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ABSTRACT

Developed through close coordination between contractors, construction workers, and vocational educators, this instructor's manual is designed to help heavy equipment instructors present materials in a systematic format. The instructional materials in the manual are written in terms of student performance, using measurable behavioral objectives. Criterion-referenced evaluation instruments provide for a uniform measurement of student progress. The manual contains four sections, organized into 14 units, each consisting of eight components: performance objectives, suggested activities for the teachers, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. Units of instruction are designed for use in more than one lesson or class period. The first section introduces the course, providing information on the free enterprise system, economics of free enterprise, the heavy equipment industry, and safety and first aid. The second section covers mathematics needed for heavy equipment operators, while related information on soil, equipment, rigging, and oxyacetylene cutting are discussed in the third section. The final section covers principles of engine operation, including gasoline and diesel engines, the drive train, and preventive maintenance. Materials are illustrated with drawings and photographs. (KC)

ED229543

Heavy Equipment Operator Instructional Materials

Basic Core

Volume I

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HEAVY EQUIPMENT OPERATOR INSTRUCTIONAL MATERIALS
CORE INSTRUCTION
VOLUME I

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FOREWORD

Leaders in the construction industry face an endless challenge when training workers. In an effort to promote high-quality and uniform training programs in this industry, representatives of Associated General Contractors of America entered into an agreement with the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center to develop training materials. Since 1973 five AGC-CIMC manuals have been developed, distributed, and used in local chapters.

In June of 1980, work began on another new manual. The focus of this publication was to be on training the operator working in industrial and commercial construction sites. The contents of *Heavy Equipment Operator Instructional Materials: Core Instruction (Vol. I)* are the product of close coordination between contractors, construction workers, and vocational educators. Without a doubt, this manual represents a conscious effort to meld the practical experience of the construction industry with the expertise of developers of instructional materials in the vocational education field.

The purpose of this manual is to assist heavy equipment instructors in providing a high caliber instructional program. Although the format reflects the organization of a systematic approach to instructional materials development and the latest in educational technology innovations, the information in *Heavy Equipment Operator Instructional Materials: Core Instruction (Vol. I)* should be adapted and modified to coincide with local conditions. Lastly, it is intended that the materials be coupled with the instructor's own methods, experience, and additional materials to make the training process complete.

Dr. Francis T. Tuttle, Director
Oklahoma State Department of
Vocational and Technical Education

Robert B. Fay, Chairman
Manpower and Training Committee
Associated General Contractors of America

PREFACE

For many years contractors and those responsible for training operators have felt the need for instructional materials to be used in training the heavy equipment operator. In 1980, the Associated General Contractors of America, with the cooperation and support of the Oklahoma State Department of Vocatonal and Technical Education, Curriculum and Instructional Materials Center, accepted the challenge to produce a manual for use in training heavy equipment operators in those areas in which they are expected to be proficient.

Instructional material in this manual is written in terms of student performance, using measurable behavioral objectives. This is an innovative approach to teaching which accents and augments the teaching-learning process. Criterion-referenced evaluation instruments provide for a uniform measurement of student progress.

Equipment operator instructors are faced with the challenge of providing students with the skill and related information necessary to meet the demands of a changing profession. Competition for jobs is greater than ever. Therefore, the operator must be better trained and better equipped to find and retain meaningful employment.

The purpose of this manual is to assist equipment operator instructors in providing instruction throughout the industry. This publication should be supplemented by each instructor's methods and materials. Any information in this manual that does not concur with the instructor's course of study can very easily be modified to meet personal needs.

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Much of the work that goes into the making of a manual is not apparent when using the book. There are many people behind the scenes who make a publication possible. Special appreciation is extended to all the staff in the Word Processing Center for making sure the final typed copies are of the highest quality. The art work in this book also deserves special commendation. Special thanks to all of you in the Art Department for the drawings you contributed to this book.

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Laborn J. "Bud" Hendrix, Curriculum Writer
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USE OF THIS PUBLICATION

Instructional Units

Heavy Equipment Operator Instructional Materials: Core Instruction, Volume I includes four instructional areas (sections). A standard format was established in 1970 for the development of instructional materials for all Oklahoma vocational teachers. This format includes eight basic components which form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. Depending on the specific objectives, transparency masters, assignment sheets, and job sheets may or may not be included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching-learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help him or her determine the following

A. Amount of material that can be covered in each class period
B. Skills which must be demonstrated
  1. Supplies and equipment needed
  2. Amount of practice needed
  3. Amount of class time needed for demonstrations
C. Supplementary materials, such as pamphlets and filmstrips, that must be ordered
D. Resource people who must be contacted

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction, and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important that teachers and students have a common understanding of the intent of the objectives. Following is a list of performance terms, their meanings, and behavioral synonyms which may have been used in this material.

A. Name--The individual supplies a name for objects, events, or people

Behavioral synonyms: Label, list, letter, record, reiterate, repeat, write

B. Identify--The individual selects a named, described, or pictured object by pointing to it, touching it, picking it up, or selecting it

Behavioral synonyms: Select, mark, match, choose, judge

C. State a rule–The individual communicates a relationship or principle which could be used to solve problems or perform a task

D. Apply a rule--The individual supplies an answer to a problem by using a stated relationship or principle

Behavioral synonyms: Solve, calculate

E. Describe--The individual relates sufficient characteristics or properties of an object or event so that a second individual will be able to state what is being discussed

Behavioral synonyms: Define, discuss, interpret, recite, tell how, tell what happens when

F. Distinguish--The individual selects an object or event from two or more which are easily confused

Behavioral synonyms: Discriminate, differentiate

G. Order--The individual arranges three or more objects or events in a sequence based on a stated property

Behavioral synonyms: Arrange, sequence, list in order, classify, divide, isolate, sort

H. Construct--The individual makes a physical object, a verbal statement, or a drawing

(NOTE: Construct is used when the finished product or result is important.)

Behavioral synonyms: Draw, make, build, design, formulate, reproduce, transcribe, convert, put together, compile

I. Demonstrate--The individual performs several operations necessary to carry out a specified process

(NOTE: *Demonstrate* is used when it is desirable to watch the student perform a task, one of the highest levels of student performance.)

Behavioral synonyms: Show your work, show procedure, perform an experiment, perform the steps, operate, remove, replace, turn off/on, (dis) assemble, (dis) connect

The objectives should be provided for students and stressed throughout the teaching-learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught.

The objective sheet may be also used as a quick pretest to determine prior knowledge of students and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Suggested Activities (pink pages)

This component is included only in teacher material. The suggested activities page assists teachers during the preparation stage of the teaching-learning process by providing suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed are ones used in the development of each unit. They should be used by the teacher to supplement knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Transparency Masters (white pages in teacher material and green in student material)

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheet. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. It is recommended that teachers stand away from the overhead projector when discussing transparency material to avoid speaking too loudly.

Assignment Sheets (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience with the information. They assist students in the application of knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided, when appropriate, and can be used by the student and/or teacher for checking student progress.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

A teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet accordingly to the equipment and supplies available in the local lab or shop situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Tests (yellow pages)

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

The tests may be written or oral. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test--eighty-five percent in most units--may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score along with teacher evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

These components are designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center is assigned a specific abbreviation. For example, *Heavy Equipment Operator Instructional Materials: Core Instruction, Volume I* has been abbreviated HEO I. The units are then numbered consecutively within each section. An example of a page number is HEO I - 1-A. Because CIMC publications are loose-leaf, this system of page numbering was adopted so that pages from different manuals would not get mixed up.

Methods of Disseminating Material

Material may be given out a unit or page at a time to keep the material before the students always new. Some teachers ask students to furnish a three-ring binder for the units while studying a particular unit. This is more convenient for taking the materials home to study. Each unit is then placed in the larger binders upon its completion. The large binders may be purchased at cost from the CIMC. Some teachers have stored the materials by units in filing cabinets or boxes until needed for use. All the units may be given out at once if desired.

Student materials should be provided for each student for best results. Student materials contain everything but the test answers, answers to assignment sheets, and suggested activities. The tests are collated at the back of student material and should be removed and stored until needed. Students should be allowed to take their materials home at the end of the year.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

FREE ENTERPRISE SYSTEM
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain how the free enterprise system works, interpret a flow chart for the production of goods and services in the free market system, and draw a conclusion about the characteristics most important to being a successful entrepreneur. This knowledge will be evidenced by completion of assignment sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the free enterprise system to the correct definitions.
2. Select from a list the essential components of the free enterprise system.
3. Discuss ways the free enterprise system affects consumers.
4. Discuss ways the free enterprise system affects business and industry.
5. Label a flow chart showing production of goods and services in the free market system.
6. Select from a list characteristics of successful entrepreneurs.
7. Complete free enterprise system crossword puzzle.
8. Analyze components of the free enterprise system.
9. Interpret flow chart for production of goods and services.
10. Survey local equipment dealers.
11. Draw a conclusion about the characteristics most important to being a successful entrepreneur.

FREE ENTERPRISE SYSTEM
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Make transparency.

   B. Order "Checklist for Going Into Business."

   (NOTE: The booklet may be obtained free of charge by contacting the Small Business Administration, 200 N.W. 5th Street, Oklahoma City, Oklahoma 73102.)

   C. Provide student with objective sheet.

   D. Provide student with information and assignment sheets.

   E. Discuss unit and specific objectives.

   F. Discuss information and assignment sheets.

   G. Arrange for a number of entrepreneurs to speak to the students. The speakers should talk about subjects such as:

      1. "How They Became Interested in Owning Their Own Business"

      2. "How They Selected Their Particular Type of Business"

      3. "Supply of and Demand for Their Goods or Services"

      4. "Outlook for the Future of Their Business"

   (NOTE: Provide time for a question and answer session.)

   H. Arrange to have a representative of the Small Business Administration speak to the students. The speaker should talk about the questions people should ask themselves before starting a business.

   (NOTE: Provide time for a question and answer period.)

   I. Give test.

   J. Reteach if necessary.

II. Instructional materials:

   A. Objective sheet

   B. Information sheet

   C. Transparency master: TM 1--The Free Market System

D. Assignment sheets

  1. Assignment Sheet #1--Complete Free Enterprise System Crossword Puzzle
  2. Assignment Sheet #2--Analyze Components of the Free Enterprise System
  3. Assignment Sheet #3--Interpret Flow Chart for Production of Goods and Services
  4. Assignment Sheet #4--Survey Local Equipment Dealers
  5. Assignment Sheet #5--Draw a Conclusion About the Characteristics Most Important to Being a Successful Entrepreneur

E. Answers to assignment sheets

F. Test

G. Answers to test

III. Unit references:

A. Nelson, Robert E.; Leach, James A.; and Scalan, Thomas J. *Owning and Operating a Small Business: Strategies for Teaching Small Business Ownership and Management.* State Board of Education, Illinois Office of Education, June 1976.

B. Nelson, Frank W. *Group Instruction for Cooperative Programs.* Stillwater: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1978.

C. Amos, Joe. *Distributive Education I: Course of Study.* Stillwater: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1973.

D. *Small Marketers Aid No. 71.* "Checklist for Going Into Business." Washington, D.C.: Small Business Administration, August 1970.

(NOTE: The booklet may be obtained free of charge by contacting the Small Business Administration, 200 N.W. 5th Street, Oklahoma City, Oklahoma 73102.)

FREE ENTERPRISE SYSTEM
UNIT I

INFORMATION SHEET

I. Terms and definitions (Assignment Sheet #1)

  A. Private property--Portion of a person's income that is kept in the form of savings, investments, or personal possessions

  B. Free market system--Consumers and producers have freedom of choice and their choices determine what shall be produced, how much shall be produced, and the price to be paid

  C. Profit--Difference between selling price and expenses necessary to produce and sell goods and services

  (NOTE: Gross profit is what remains after the cost of the actual goods or services is subtracted from the selling price. Net profit is what remains after all expenses, such as advertising, rent, salaries, and depreciation, are subtracted.)

  D. Competition--Effort of businesses or individuals acting independently to attract the consumers' dollars

  E. Free enterprise system--System that allows businesses and individuals to make their own choices about what they will do to earn a livelihood and how they will spend their money

  F. Entrepreneur--Person who organizes and manages a business, assuming the risk of the business for the purpose of making a profit

II. Essential components of the free enterprise system (Assignment Sheet #2)

  A. Private property

  B. Free markets

  C. Profit motivation

  D. Competition

III. Ways the free enterprise system affects consumers

  A. Private property--May provide earned income for consumer through profits made from investment

  Example: A consumer may invest savings in the Angus Bulldozer Company; this creates the potential for the consumer to earn income through the profits of the company

INFORMATION SHEET

B. Free markets--Allow consumers, through their buying decisions, to maintain the balance between supply and demand and price of goods and services

Example: When the Angus Bulldozer was placed on the market the supply was limited and the demand was high; the result was a high price for a bulldozer. A majority of consumers could not afford it. For this reason a large part of the market was not being reached. In response to this situation, the Angus Bulldozer Company produced several lower priced dozers.

C. Profit motivation--Consumers receive new and/or quality goods and services as a result of the desire for profit by business and industry

(NOTE: Business and industry are organizations that produce or distribute goods and services.)

Example: The Angus Bulldozer was an improvement on the conventional dozer and was produced as a result of a business's desire to increase profit.

D. Competition--Competition among business and industry results in reasonable prices and better quality goods and services for consumers

Example: The consumers' demand for the Angus Bulldozer was high; as a result, several companies began to produce similar bulldozers; the competition worked to keep down prices and resulted in many improvements in the bulldozer

IV. Ways the free enterprise system affects business and industry

A. Private property--Business and industry can raise funds necessary for operation as a result of the private property invested by consumers

B. Free markets--Supply and price of goods and services is determined by consumer demand

Example: The Angus Bulldozer was in demand but the majority of consumers could not afford the price; this demand resulted in the production of lower priced bulldozers. Other companies started to produce bulldozers, so the supply was increased and price became even more reasonable.

C. Profit motivation--Encourages forming of business; provides goods and services; creates jobs

INFORMATION SHEET

D. Competition--Limits prices business and industry can demand for their goods and services

Example: The Angus Bulldozer was the only product of its type being produced for a period of time; several other companies soon began to produce similar equipment. This competition has made it necessary for all companies to keep prices competitive and has encouraged improvements in the bulldozer

V. Flow chart for production of goods and services in the free market system (Transparency 1, Assignment Sheet #3)

A. Goods and services--Goods are such items as clothes, food, houses and automobiles; services are such items as medical care, hair care, dry-cleaning, and airline transportation

B. Demand for goods and services--Consumers' desire to buy items such as clothing or medical care

C. Factors of production--Resources used by business and industry to produce goods and services

(NOTE: Four basic resources are used in the production of goods and services: land, labor, capital and the entrepreneur.)

D. Payment for factors of production

(NOTE: Payment is in the form of rent, wages, interest, and dividends.)

VI. Characteristics of successful entrepreneurs (Assignment Sheets #4 and #5)

A. Ability to organize

B. Leadership ability

C. Ability to solve problems

D. Ability to make and be responsible for decisions

E. Enthusiastic and energetic

F. Ability to communicate

G. Works well with people

H. Willing to work hard and long hours

I. Willing to take risks

INFORMATION SHEET

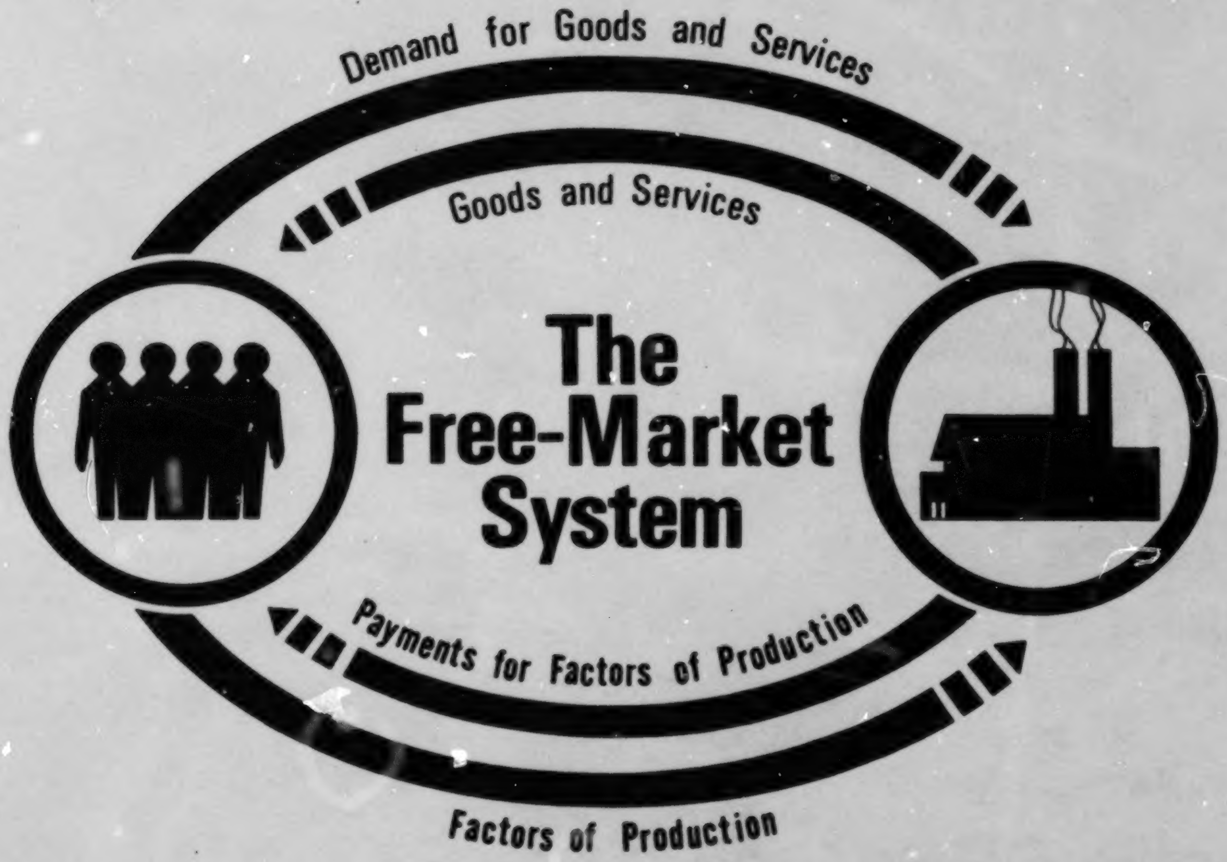
J. Independent

K. Possesses technical knowledge

L. Self-confident

(NOTE: It is not necessary that a person possess all these characteristics to be a successful entrepreneur, but a successful entrepreneur will possess the majority of them.)

The Free Market System



Demand for Goods and Services

Goods and Services

The Free-Market System

Payments for Factors of Production

Factors of Production

FREE ENTERPRISE SYSTEM
UNIT I

ASSIGNMENT SHEET #1--COMPLETE FREE ENTERPRISE SYSTEM CROSSWORD PUZZLE

NAME ______________________ SCORE ______________

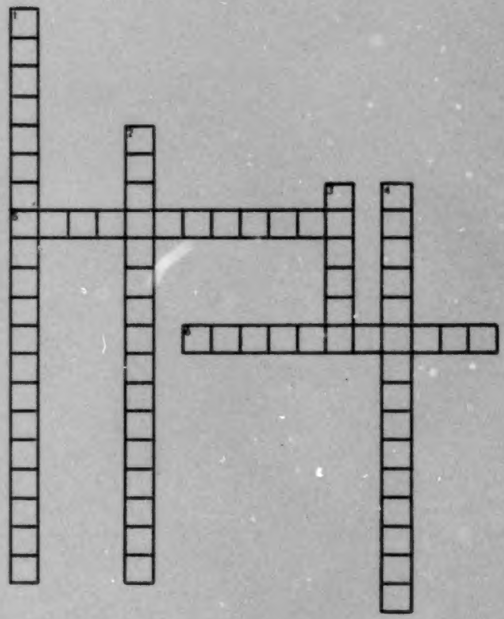
Use the following definitions as a guide in completing the crossword puzzle.

Down:

1. System that allows businesses and individuals to make their own choices about what they will do to earn a livelihood and how they will spend their money
2. Consumers and producers have freedom of choice and their choices determine what shall be produced, how much shall be produced, and the price to be paid
3. Difference between selling price and expenses necessary to produce and sell goods and services
4. Portion of a person's income that is kept in the form of savings, investments, or personal possessions

Across:

5. Person who organizes and manages a business, assuming the risk of the business for the purpose of making a profit
6. Effort of businesses or individuals acting independently to attract the consumers' dollars



FREE ENTERPRISE SYSTEM
UNIT I

ASSIGNMENT SHEET #2--ANALYZE COMPONENTS OF THE FREE ENTERPRISE SYSTEM

NAME ______________________________ SCORE ____________

1. Use the yellow pages of the telephone book to determine the number of business firms competing for the consumers' dollars for the following goods and services. Write the names of the companies or businesses in the blanks provided.

   a. Equipment rentals

      1) ____________________
      2) ____________________
      3) ____________________
      4) ____________________
      5) ____________________
      6) ____________________
      7) ____________________
      8) ____________________

   b. Day nurseries and child care centers

      1) ____________________
      2) ____________________
      3) ____________________
      4) ____________________
      5) ____________________
      6) ____________________
      7) ____________________
      8) ____________________
      9) ____________________
      10) ____________________

   c. Income tax services

      1) ____________________
      2) ____________________
      3) ____________________
      4) ____________________
      5) ____________________
      6) ____________________

   d. Excavation/equipment dealers

      1) ____________________
      2) ____________________
      3) ____________________
      4) ____________________
      5) ____________________
      6) ____________________

   e. Telephone companies

      1) ____________________
      2) ____________________
      3) ____________________
      4) ____________________

ASSIGNMENT SHEET #2

f. Hospitals (general medical and services)

1) ____________________ 3) ____________________

2) ____________________ 4) ____________________

2. Analyze the information collected in the survey to answer the following questions.

a. Which business appears to have the most competition for consumers' dollars?

____

Explain your answer. ______________________________

____

____

b. How do most firms demonstrate the free market system?

____

____

____

c. What did the survey show you about profit motivation and business firms in your area?

____

____

____

d. What did the survey show about the use of private property used by business?

____

____

ASSIGNMENT SHEET #2

3. Read the following case studies to demonstrate how components of the free enterprise system are at work. Write an "X" in the blank opposite the components you believe are at work and explain your answers.

(NOTE: More than one answer may be correct.)

a. Jane Smith has $35,000 in savings and plans to use the money to open a trucking company. Jane conducted a survey of the people in the city in which she wants to locate the business. The survey shows a need for a trucking company, so Jane decides to open the business.

1) _____Private property. Why?______________________________

____

____

2) _____Free markets. Why?______________________________

____

____

3) _____Profit motivation. Why?______________________________

____

____

4) _____Competition. Why?______________________________

____

____

____

b. John Jones owns and operates a safety equipment and clothing store. John employs four sales persons and a stock clerk. He has decided to change his business from a full-service to a self-service store in an effort to lower expenses and increase profits. The number of employees will be reduced to two, a cashier and a stockperson.

1) _____Private property. Why?______________________________

____

____

ASSIGNMENT SHEET #2

2) _____Free markets. Why?______________________________

____

____

3) _____Profit motivation. Why?______________________________

____

____

4) _____Competition. Why?______________________________

____

____

c. Pat James owns and operates an equipment repair shop. Pat has decided to increase the services provided by the shop in an effort to increase sales. The services that will be added are transmission and exhaust system repair. Pat will have to borrow $10,000 from a relative to add these services.

1) _____Private property. Why?______________________________

____

____

2) _____Free markets. Why?______________________________

____

____

3) _____Profit motivation. Why?______________________________

____

____

4) _____Competition. Why?______________________________

____

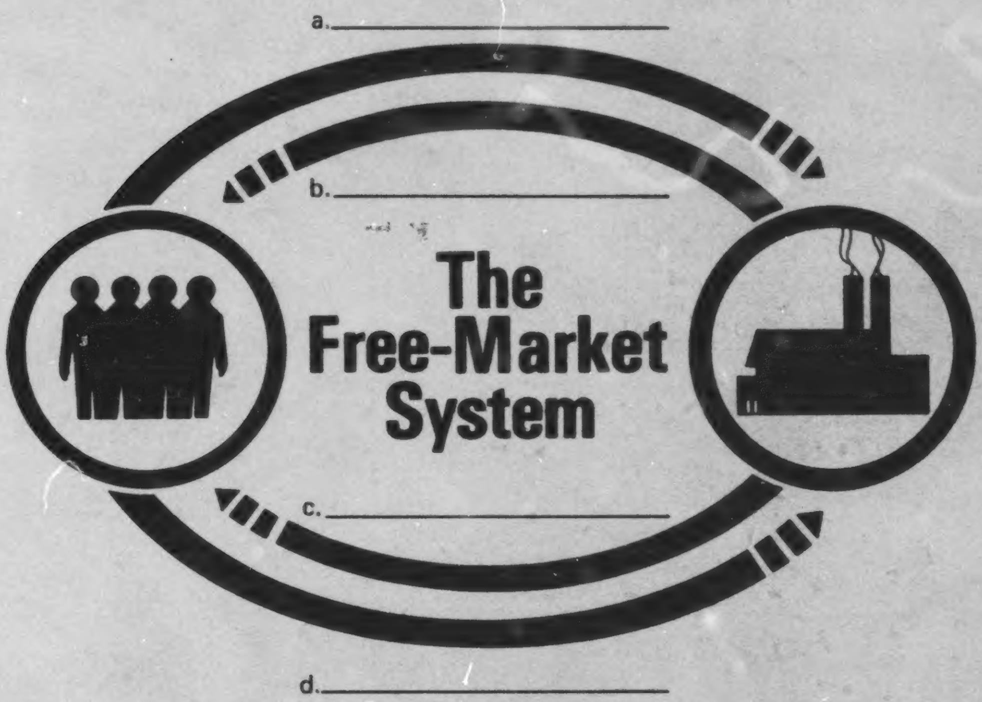
____

FREE ENTERPRISE SYSTEM
UNIT I

ASSIGNMENT SHEET #3--INTERPRET FLOW CHART FOR PRODUCTION OF GOODS AND SERVICES

NAME______________________________________ SCORE______________________

1. Label the flow chart for the production of goods and services in the free market system.



2. How would the following changes within the free market system normally affect the flow chart for the production of goods and services? Mark an "X" by the correct answer.

   a. If consumers' demand for goods and services increases and the business produces more goods and services, the business's demand for production resources will:

      ______1) Increase

      ______2) Decrease

      ______3) Not change

ASSIGNMENT SHEET #3

b. If business demands more production resources and consumers supply more, payment to consumers for resources will:

_____1) Increase

_____2) Decrease

_____3) Not change

c. If consumers' demand for goods and services increases, the amount of goods and services produced by business will:

_____1) Increase

_____2) Decrease

_____3) Not change

d. If business pays less for production resources, then the amount paid by consumers should:

_____1) Increase

_____2) Decrease

_____3) Not change

e. If business produces less goods and services and consumers demand equally less goods and services, the cost paid by consumers for goods and services should:

_____1) Increase

_____2) Decrease

_____3) Not change

f. If consumers provide more production resources while business's demands for production resources remain the same, the amount business pays for resources will:

_____1) Increase

_____2) Decrease

_____3) Not change

FREE ENTERPRISE SYSTEM
UNIT I

ASSIGNMENT SHEET #4--SURVEY LOCAL EQUIPMENT DEALERS

NAME________________________________ SCORE____________________

Survey three local equipment dealers to determine why the cost of hydraulic cranes has increased so rapidly in the past four years.

EQUIPMENT DEALER	REASONS GIVEN FOR RAPID INCREASE IN COST OF HYDRAULIC CRANES
Dealer #1	
Dealer #2	
Dealer #3	

FREE ENTERPRISE SYSTEM
UNIT I

ASSIGNMENT SHEET #5--DRAW A CONCLUSION ABOUT THE CHARACTERISTICS MOST IMPORTANT TO BEING A SUCCESSFUL ENTREPRENEUR

NAME____________________________ SCORE__________________

1. Survey six individuals in your area to collect information about what they think the term *entrepreneur* means and what characteristics should be possessed to be a successful entrepreneur. These six individuals should be comprised of two business persons, two adults who do not operate their own business, and two students not enrolled in this program.

PERSON SURVEYED	MEANING OF ENTREPRENEUR	CHARACTERISTICS OF A SUCCESSFUL ENTREPRENEUR
Business person #1		
Business person #2		
Student #1		
Student #2		
Adult #1		
Adult #2		

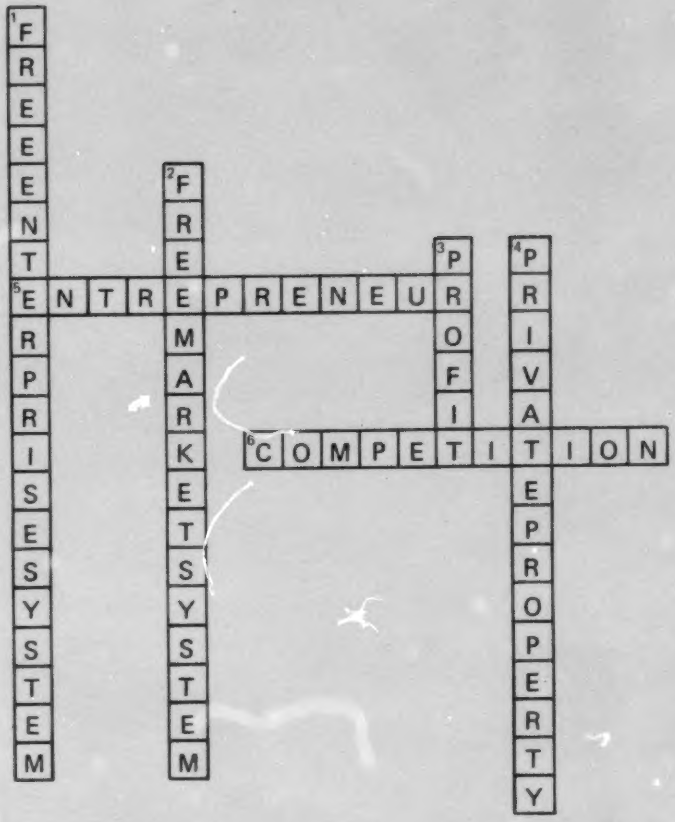
ASSIGNMENT SHEET #5

2. Consider the information obtained in the survey and the information sheets about the characteristics of a successful entrepreneur. In the space below, write what you believe to be the most important characteristics.

FREE ENTERPRISE SYSTEM
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1


1 FREEENTERPRISESYSTEM
2 FREEMARKETSYSTEM
3 PROFIT
4 PRIVATEPROPERTY
5 ENTREPRENEUR
6 COMPETITION

Assignment Sheet #3

1. a. Demand for goods and services
   b. Goods and services
   c. Payment for factors of production
   d. Factors of production
2. a. 1
   b. 1
   c. 1
   d. 2
   e. 3
   f. 2

FREE ENTERPRISE SYSTEM
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with the free enterprise system to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Person who organizes and manages a business, assuming the risk of the business for the purpose of making a profit

_____b. Portion of a person's income that is kept in the form of savings, investments, or personal possessions

_____c. System that allows businesses and individuals to make their own choices about what they will do to earn a livelihood and how they will spend their money

_____d. Effort of businesses or individuals acting independently to attract the consumers' dollars

_____e. Consumers and producers have freedom of choice and their choices determine what shall be produced, how much shall be produced, and the price to be paid

_____f. Difference between selling price and expenses necessary to produce and sell goods and services

1. Free market system
2. Competition
3. Entrepreneur
4. Profit
5. Private property
6. Free enterprise system

2. Select from the following list the essential components of the free enterprise system. Mark each correct answer with an "X."

_____a. Public property

_____b. Profit motivation

_____c. Competition

_____d. Free markets

_____e. Assets

_____f. Private property

3. Discuss ways the free enterprise system affects consumers.

   a. Private property-- ______________________________

   b. Free markets-- ______________________________

   c. Profit motivation-- ______________________________

   d. Competition-- ______________________________

4. Discuss ways the free enterprise system affects business and industry.

   a. Private property-- ______________________________

   b. Free markets-- ______________________________

c. Profit motivation-- ____

____

____

____

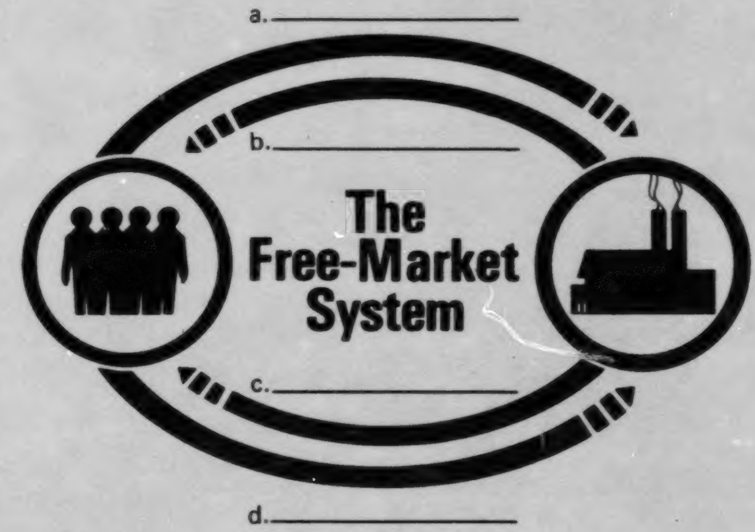
d. Competition-- ____

____

____

____

5. Label the flow chart for production of goods and services in the free market system.



6. Select from the following list the characteristics of successful entrepreneurs. Mark each correct answer with an "X."

_____a. Lacks self-confidence

_____b. Ability to organize

_____c. Leadership ability

______d. Has ill health

______e. Ability to make and be responsibile for decisions

______f. Dependent on others

______g. Enthusiastic and energetic

______h. Ability to communicate

______i. Does not like to deal with problems

______j. Willing to take risks

7. Complete free enterprise system crossword puzzle.
8. Analyze components of the free enterprise system.
9. Interpret flow chart for production of goods and services.
10. Survey local equipment dealers.
11. Draw a conclusion about the characteristics most important to being a successful entrepreneur.

(NOTE: If activities 7 through 11 have not been finished before the test, ask your instructor when they should be completed.)

FREE ENTERPRISE SYSTEM
UNIT I

ANSWERS TO TEST

1. a. 3   d. 2
   b. 5   e. 1
   c. 6   f. 4
2. b, c, d, f
3. Discussion should include:
   a. May provide earned income for consumer through profits made from investment
   b. Allow consumers, through their buying decisions, to maintain the balance between supply and demand and price of goods and services
   c. Consumers receive new and/or quality goods and services as a result of the desire for profit by business and industry
   d. Competition among business and industry results in reasonable prices and better quality goods and services for consumers
4. Discussion should include:
   a. Business and industry can raise funds necessary for operation as a result of the private property invested by consumers
   b. Supply and price of goods and services is determined by consumer demand
   c. Encourages forming of business; provides goods and services; creates jobs
   d. Limits prices business and industry can demand for their goods and services
5. a. Demand for goods and services
   b. Goods and services
   c. Payment for factors of production
   d. Factors of production
6. b, c, e, g, h, j
7. Evaluated to the satisfaction of the instructor
8. Evaluated to the satisfaction of the instructor
9. Evaluated to the satisfaction of the instructor

10. Evaluated to the satisfaction of the instructor

11. Evaluated to the satisfaction of the instructor

ECONOMICS OF FREE ENTERPRISE
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to select from a list the major characteristics of the modified free enterprise system, analyze a supply and demand schedule, list the factors that determine the degree of elasticity of demand, and interpret the factors of price that influence the economy. This knowledge will be evidenced by completion of assignment sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with economics of free enterprise to the correct definitions.
2. Select from a list major characteristics of the modified free enterprise system.
3. Discuss roles of the government in the economy.
4. Match economic goals of American people to correct descriptions.
5. Match factors of production to correct definitions.
6. Describe function of supply and demand.
7. List factors that determine the degree of elasticity of demand.
8. Select from a list factors of price that influence the economy.
9. Collect information on the role of government in the economy.
10. Analyze a supply and demand schedule.
11. Interpret factors of price that influence the economy.

ECONOMICS OF FREE ENTERPRISE
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information and assignment sheets.

   E. Order the film series *American Enterprise: Land, Government, and Innovation.*

   F. Arrange for a State Senator or Representative from your area to speak to the students on the government's role in the economy.

   (NOTE: Provide time for a question and answer session.)

   G. Give test.

II. Instructional materials:

   A. Objective sheet

   B. Information sheet

   C. Assignment sheets

      1. Assignment Sheet #1--Collect Information on the Role of Government in the Economy

      2. Assignment Sheet #2--Analyze a Supply and Demand Schedule

      3. Assignment Sheet #3--Interpret Factors of Price that Influence the Economy

   D. Answers to assignment sheets

   E. Test

   F. Answers to test

III. Unit references:

   A. Nelson, Frank W. *Group Instruction for Cooperative Programs.* Stillwater: Oklahoma State Department of Vocational and Technical Education/ Curriculum and Instructional Materials Center, 1978.

   B. Wyllie, Eugene D., and Warmke, Roman F. *Free Enterprise in the United States.* Cincinnati: South-Western Publishing Co., 1980.

C. Broom, H. N., and Longenecker, Justin G. *Small Business Management.* Cincinnati: South-Western Publishing Co., 1979.

IV. Films--*American Enterprise Series*

(NOTE: This series is available on a free-loan basis to Oklahoma instructors *only* from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1515 West Sixth Avenue, Stillwater, Oklahoma 74074. Out-of-state instructors must order from the address listed below.)

1. *American Enterprise Series: Land.* Color, 29 min., Modern Talking Picture Service, 1976. Available from Modern Talking Picture Service, 45 Rockefeller Plaza, New York, N.Y. 10020.
2. *American Enterprise Series: Government.* Color, 29 min., Modern Talking Picture Service, 1976. Available from Modern Talking Picture Service, 45 Rockefeller Plaza, New York, N.Y. 10020.
3. *American Enterprise Series: Innovation.* Color, 29 min., Modern Talking Picture Service, 1976. Available from Modern Talking Picture Service, 45 Rockefeller Plaza, New York, N.Y. 10020.

ECONOMICS OF FREE ENTERPRISE
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Modified free enterprise system--System in which businesses and individuals are not totally free to make their own choices about what they will do to earn a livelihood and how to spend their money; laws at the federal, state, and local levels regulate these decisions

B. Economy--System for the production, distribution, and consumption of goods and services

C. Economic system--Process for allocation of the factors of production

Examples: Capitalism, Socialism, Communism

D. Economics--Study of the process by which the factors of production are allocated to produce goods and services to satisfy the consumers' needs

E. Allocation--Selection of the ways that the factors of production will be used to produce goods and services

F. Elasticity of demand--Effect that a change in the purchase price for a good or service has on the quantity that consumers will buy

G. Elastic demand--Change in price for a good or service causing a considerable change in the quantity consumers will buy

H. Inelastic demand--Change in price for a good or service not causing a considerable change in the quantity consumers will buy

II. Major characteristics of the modified free enterprise system

A. Federal, state, and local governments influence how the factors of production will be used

B. Desire for profit is the primary motive for businesses and individuals

C. Competition promotes efficient methods of production and improvements in goods and services

D. Existence of some monopolistic business is permitted

(NOTE: A monopolistic business is the only producer of a good or service. It has no competition.)

E. The consumers' choice of what to buy determines the type and quantity of goods and services produced

F. Provides freedom of choice for employment and grants the right to own property and enter into contracts

G. System used to buy goods and services

INFORMATION SHEET

III. Roles of the government in the economy (Assignment Sheet #1)

A. Producer and consumer of goods and services

(NOTE: Government pays for factors of production used in production and delivery of goods and services by the collection of taxes.)

1. Federal government provides military defense, national parks and recreational facilities, interstate highways, social security, health care, postal service
2. State government provides state and interstate highways; educational facilities; state parks and recreational facilities; state police protection; assistance to the aged, handicapped, and disadvantaged; health care
3. Local government provides streets, water and sewage facilities, police and fire protection, libraries, health care

B. Regulator

1. Regulates and inspects goods and services

   Examples: Federal Trade Commission, Environmental Protection Agency, Food and Drug Administration, Public Utilities Commission, Occupational Safety and Health Act, Building Codes

2. Establishes and enforces employment standards

   Examples: National Labor Relations Board, Equal Employment Opportunity Commisssion, Wage and Salary Administration

3. Regulates business, particularly large businesses

   Examples: Securities and Exchange Commission, Federal Communications Commission, Federal Reserve Board

IV. Economic goals of American people

(NOTE: In a free enterprise system people are free to determine their own goals. People set their own goals and use the factors of production to fulfill their wants and needs. People have individual wants and needs, but Americans in general have certain economic goals.)

A. Economic freedom--To have free choice in making economic decisions

Examples: Freedom to start a business, buy a new car, add a room onto the house, put money into a savings account, or spend it

INFORMATION SHEET

B. Economic efficiency–To use factors of production in the most efficient manner

C. Economic growth--To have an ever-increasing standard of living

Examples: Better medical care, housing, clothing, education, highways, salaries, police protection

D. Economic stability–To avoid ups and downs in the economy, such as inflation, recession, and depression

E. Economic security–To have a certain minimum standard of living

Examples: Social security, Medi-Care, government work programs, unemployment compensation insurance, price supports, welfare benefits, food stamps

F. Economic justice--To have fair distribution of the wealth of the nation based on productivity

V. Factors of production

A. Land–Consists of such items as land, water, oil, natural gas, coal, and uranium

(NOTE: Land is sometimes referred to as *natural resources*.)

B. Labor–Physical and mental effort used in the production of goods and services

C. Capital--Investment in buildings and equipment used to produce goods and services

D. Entrepreneur–Develops ideas for goods and services; organizes and operates a business to produce or sell goods and services; makes decisions for a business; assumes risks for success or failure of a business

INFORMATION SHEET

VI. Function of supply and demand (Assignment Sheet #2)

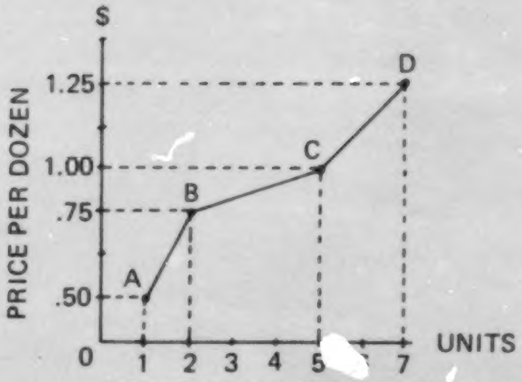
A. Supply–Quantity of a good or service that producers are willing and able to make available for consumers to buy at a specific price and time

(NOTE: Supply schedules and supply curves are two ways of showing supply information.)

Examples:

SUPPLY SCHEDULE		
Price of Eggs (per dozen)	Quantity of Eggs Supplied at that Price (per dozen)	Points on Supply Curve
$ .50	1	A
$ .75	2	B
$1.00	5	C
$1.25	7	D

SUPPLY CURVE



QUANTITY OF EGGS SUPPLIED (PER DOZEN)

1. Price is always shown on the vertical axis
2. Quantity is always shown on the horizontal axis
3. Points on the supply curve are located by use of a supply schedule
4. Supply is normally graphed as an upsloping line because more is produced as price goes up

INFORMATION SHEET

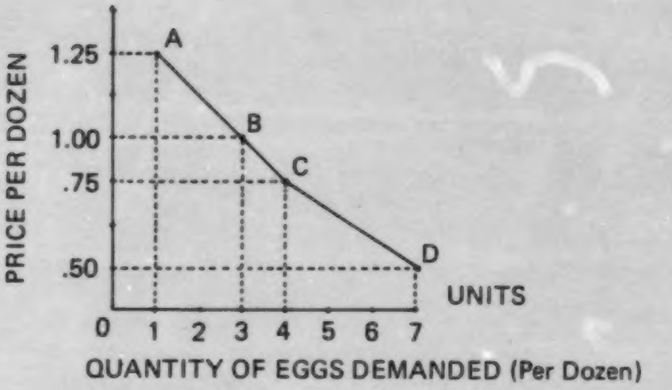
B. Demand–Quantity of a good or service that consumers are willing and able to buy at a specific price and time

(NOTE: Demand schedules and demand curves are two ways of showing demand information.)

Examples:

DEMAND SCHEDULE		
Price of Eggs (per dozen)	Quantity of Eggs Demanded at that Price (per dozen)	Points on Demand Curve
$1.25	1	A
$1.00	3	B
$ .75	4	C
$ .50	7	D

DEMAND CURVE



1. Price is always shown on the vertical axis
2. Quantity is always shown on the horizontal axis
3. Points on a demand curve are located by use of a demand schedule
4. Demand is normally graphed as a downsloping line because more is purchased as price goes down

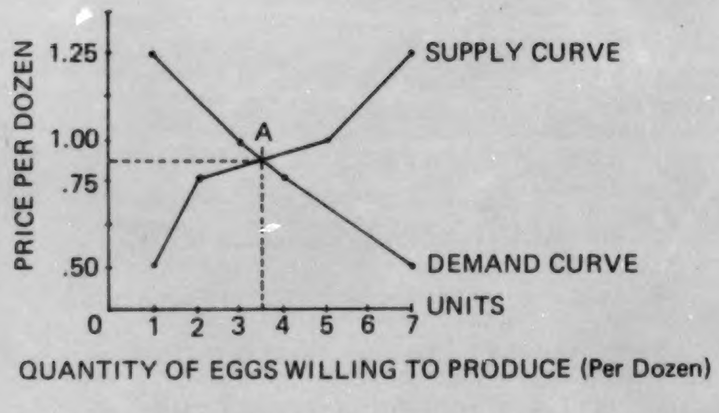
INFORMATION SHEET

C. Supply and demand--Determines the price and number of goods or services that will be produced

Examples:

SUPPLY AND DEMAND SCHEDULE		
Price of Eggs (per dozen)	Quantity of Eggs Supplied at that Price	Quantity of Eggs Demanded at that Price
$ .50	1	7
$ .75	2	4
$1.00	5	3
$1.25	7	1

SUPPLY AND DEMAND CURVE



Point "A" is the price where all the eggs produced will be sold

INFORMATION SHEET

VII. Factors that determine the degree of elasticity of demand

A. Whether a good or service is a necessity or a luxury

(NOTE: The demand for luxury goods and services is more elastic than for necessary goods and services.)

Examples: If the price of air-conditioned equipment increases, the demand will decrease considerably; if the price of electricity increases, the demand will not decrease

B. Availability of substitute products

Example: If the price of hydraulic equipment increases, consumers may buy more cable equipment

C. Amount of money consumers have available and are willing to spend

VIII. Factors of price that influence the economy (Assigment Sheet #3)

A. Price determines what will be produced by showing what goods and services are profitable

Example: The price of sand is $3.75 per ton and it cost the contractor $4.25 per ton to excavate; sand is not a profitable product for the contractor, so the contractor will have to consider producing another product, such as gravel

B. Allocation of scarce resources will be determined by price

Example: If diesel fuel is selling for $1.15 per gallon and kerosene is selling for $.90 per gallon, oil will be used primarily to produce diesel fuel

(NOTE: The consumer will produce the product which will show him or her the most profit.)

C. Methods of production for a good or service is determined by price

Example: If a home contractor can use a cheaper grade lumber to build a home and the consumer does not care, the contractor can reduce the cost of the product

D. Price of goods and services determines what consumers are able to buy

Example: If your income is $20,000.00 per year, you will not be able to buy a $250,000.00 home

INFORMATION SHEET

E. Collective buying decisions of consumers determine the price for goods and services

Example: Ten years ago large American automobiles were selling for a much lower price than foreign automobiles. Today consumers are purchasing more foreign automobiles. This demand has caused the price and supply of foreign automobiles to rise rapidly; the price of American automobiles has increased but at a much lower rate.

F. Marketing surveys and reviews of past sales records determine what goods and services consumers will buy and the price consumers will pay

G. Decision of an individual about what good or service to buy is influenced by price

Example: A contractor is shopping to buy a cherry picker and has found two that he/she would like to buy; all other things equal, the contractor will buy the lowest priced cherry picker

ECONOMICS OF FREE ENTERPRISE
UNIT II

ASSIGNMENT SHEET #1--COLLECT INFORMATION ON THE ROLE OF GOVERNMENT IN THE ECONOMY

NAME ________________________________ SCORE ______________

Part I

Interview or contact by letter at least one agency from each of the following levels of government to determine the functions the agency performs. Use the questions included in this assignment to complete the interviews.

A. **Federal**

Examples:
- Federal Trade Commission
- Food and Drug Administration
- U.S. Postal Service
- OSHA (Occupational Safety and Health Administration)
- Department of Labor--Wage and Hour Administration
- Social Security Administration

1. With what type of business does the agency work? ______________________

____

____

____

____

2. What goods or services does the agency provide to these businesses? __________

____

____

____

3. What regulatory and/or protective functions are performed for these businesses?

____

____

____

ASSIGNMENT SHEET #1

B. State

Examples:
Department of Human Services (welfare office)
State Employment Office
State Highway Department
State Department of Health
Department of Consumer Affairs
Corporation Commission

1. With what type of business does the agency work? ______________________

2. What goods or services does the agency provide to these businesses? ______________________

3. What regulatory and/or protective functions are performed for these businesses?

C. County or City

Examples:
Board of County Commissioners
County Clerk
County Tax Assessor
County Surveyor
Highway Inspector
Buildings and Codes Department
City Engineer

1. With what type of business does the agency work? ______________________

ASSIGNMENT SHEET #1

2. What goods or services does the agency provide to these businesses?___________

3. What regulatory and/or protective functions are performed for these businesses?

Part II

Interview at least two people from the following types of businesses. Use the questions that follow to complete your interviews.

A. Bank or savings and loan company

B. Excavating contractor

C. Building contractor

D. Day care center

E. Telephone company

F. Gas company or electric company

G. Hospital or nursing home

H. Demolition contractor

I. Manufacturing business

ASSIGNMENT SHEET #1

Type of business ______________________________

Name of business ______________________________

1. What goods or services are provided for the business by the following levels of government?

   a. Federal– ______________________________

   b. State– ______________________________

   c. County or city– ______________________________

2. How is their business affected by the regulatory functions performed by levels of government?

   a. Federal– ______________________________

   b. State– ______________________________

   c. County or city– ______________________________

ASSIGNMENT SHEET #1

Type of business ____________________

Name of business ____________________

1. What goods or services are provided for the business by the following levels of government?

   a. Federal-- ____________________

   b. State-- ____________________

   c. County or city-- ____________________

2. How is their business affected by the regulatory functions performed by levels of government?

   a. Federal-- ____________________

   b. State-- ____________________

   c. County or city-- ____________________

ECONOMICS OF FREE ENTERPRISE
UNIT II

ASSIGNMENT SHEET #2–ANALYZE A SUPPLY AND DEMAND SCHEDULE

NAME_______________________________ SCORE _______________

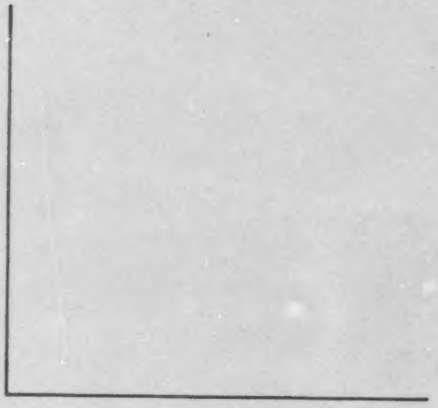
The XYZ Tire Company has conducted a survey to determine the number of tires to produce and the price to charge. The results of the survey have been placed in the following supply and demand schedule:

SUPPLY AND DEMAND SCHEDULE		
Price of Tires	Number of Tires Supplied at that Price	Number of Tires Demanded at that Price
$ 75.00	300,000	1,000,000
$100.00	500,000	900,000
$125.00	650,000	850,000
$150.00	700,000	800,000
$175.00	800,000	700,000
$200.00	950,000	600,000
$225.00	1,000,000	400,000

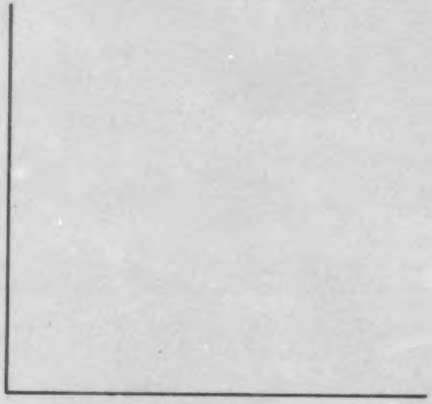
1. Construct a supply curve using the information in the above supply and demand schedule.

ASSIGNMENT SHEET #2

2. Construct a demand curve using the information in the supply and demand schedule.



3. Construct a supply and demand curve using the information in the supply and demand schedule.



ASSIGNMENT SHEET #2

4. Analyze the supply and demand curve and answer the following questions.

   a. How many tires will be produced? ______________________________

   b. What will be the price of the tires? ______________________________

ECONOMICS OF FREE ENTERPRISE
UNIT II

ASSIGNMENT SHEET #3--INTERPRET FACTORS OF PRICE THAT INFLUENCE THE ECONOMY

NAME______________________________ SCORE ____________

1. The Bench Bearing Company is planning to add one more item to the line it sells. The store can sell roller or ball bearings. The store estimates that 40,000 roller bearings can be sold at a profit of 10 cents per bearing, and 38,000 ball bearings can be sold at a profit of 12 cents per bearing.

   a. Which item should the Bench Bearing Company select to sell?

   ____

   b. Explain your decision. ____________________________

   ____

   ____

   c. Which factor of price was used to make your decision? ____________

   ____

   ____

2. John and Susan Johnson are planning to buy a new business. They have looked at two that they like. The businesses are basically the same, except "A" is located on five acres of land and "B" is located on a 100 foot by 100 foot lot. The monthly payments on "A" are $500 and $300 on "B." Based on their monthly income and their other financial obligations, the Johnsons decided they could not afford to buy "A."

   Which factor of price influenced the Johnsons' decision to buy "B?"

   ____

   ____

   ____

3. A few years ago there was a shortage of coffee in America. Because of this shortage the coffee companies raised prices. Consumers objected to the price increase and began using less coffee. The decrease in the use of coffee affected the coffee companies' profits to the point that they decided to lower prices to a more reasonable level.

   Which factor of price influenced the coffee companies' decision to lower coffee prices?

   ____

   ____

   ____

ASSIGNMENT SHEET #3

4. The Miller Clothing Company has decided to conduct a marketing survey and to review the previous year's sales records for safety clothes. The purpose of the survey and review is to determine the style of safety clothes consumers will buy and the price consumers will pay.

   Which factor of price influenced Miller's decision to conduct a survey and review sales records? ____

   ____

   ____

ECONOMICS OF FREE ENTERPRISE
UNIT II

ASSIGNMENT SHEET #3--INTERPRET FACTORS OF PRICE THAT INFLUENCE THE ECONOMY

NAME ______________________________ SCORE ____________

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   a. Which item should the Bench Bearing Company select to sell?

   ____

   b. Explain your decision. ______________________________

   ____

   ____

   c. Which factor of price was used to make your decision? ____________

   ____

   ____

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   Which factor of price influenced the Johnsons' decision to buy "B?"

   ____

   ____

   ____

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   ____

   ____

   ____

ASSIGNMENT SHEET #3

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   ____

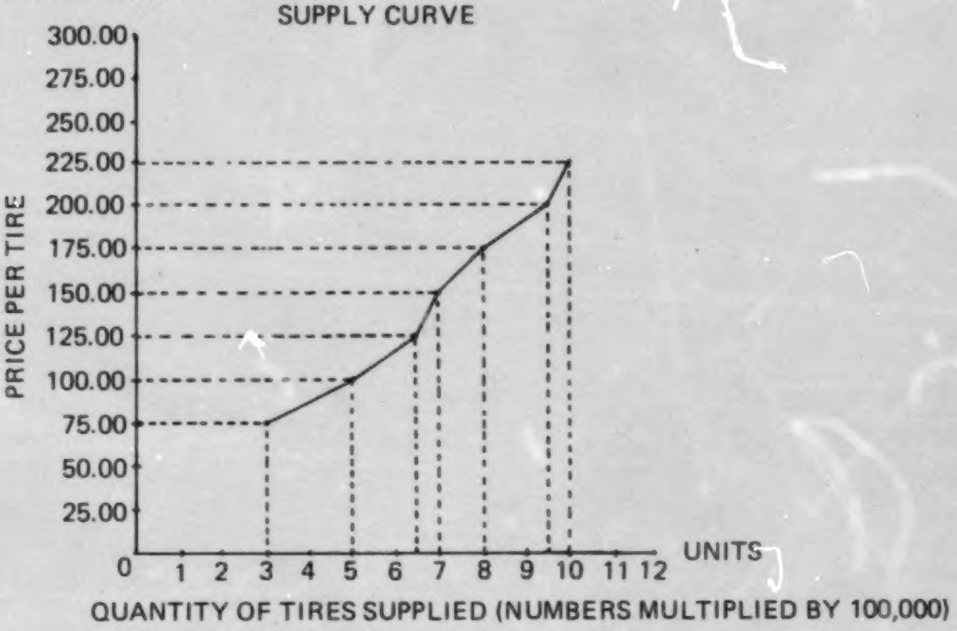
   ____

ECONOMICS OF FREE ENTERPRISE
UNIT II

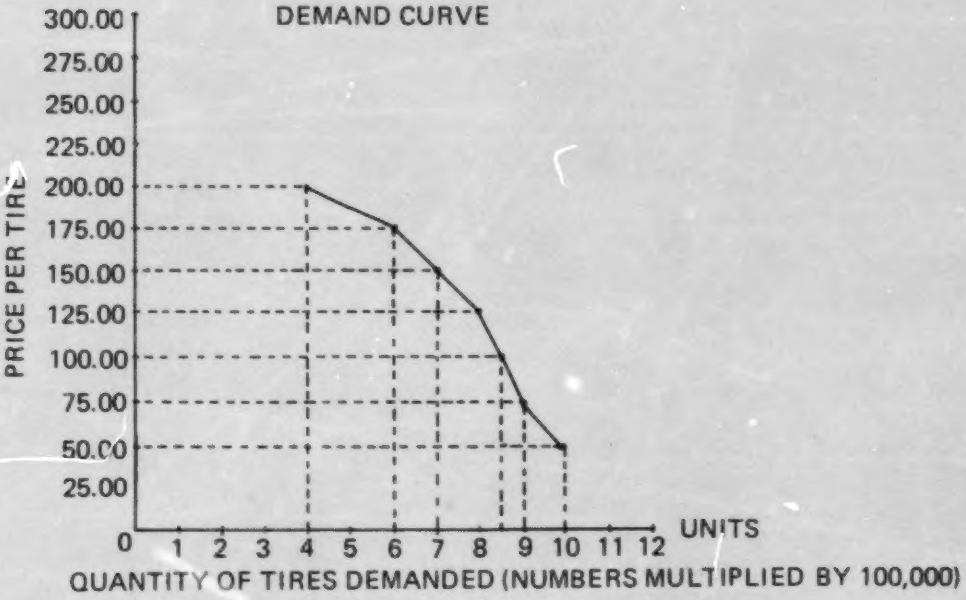
ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2

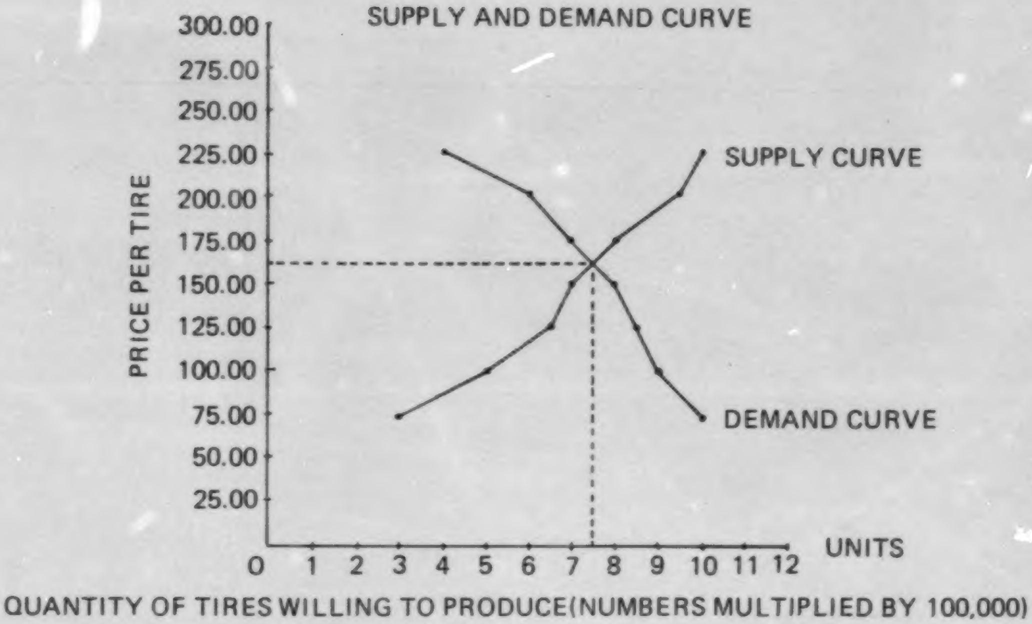
1.



2.



3.



4. a. 750,000 tires

   b. $163.00

Assignment Sheet #3

1. a. Ball bearings

   b. The profit from the sale of ball bearings equals $4,560, and the profit from the sale of roller bearings equals $4,000. The sale of ball bearings would result in an additional $560 profit.

   c. The price of goods and services determines what will be produced by showing what goods and services are profitable.

2. The price of goods and services determine what consumers are able to buy.

3. The collective buying decision of consumers determines the price for goods and services.

4. Business and industry conducts marketing surveys and reviews past sales records. This is done in an effort to determine what goods and services consumers will buy and the price consumers will pay.

ECONOMICS OF FREE ENTERPRISE
UNIT II

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with economics of free enterprise to the correct definitions. Write the correct numbers in the blanks provided.

_____a. System in which businesses and individuals are not totally free to make their own choices about what they will do to earn a livelihood and how to spend their money; laws at the federal, state, and local levels regulate these decisions

_____b. System for the production, distribution, and consumption of goods and services

_____c. Process for allocation of the factors of production

_____d. Study of the process by which the factors of production are allocated to produce goods and services to satisfy the consumers' needs

_____e. Selection of the ways that the factors of production will be used to produce goods and services

_____f. Effect that a change in the purchase price for a good or service has on the quantity that consumers will buy

_____g. Change in price for a good or service causing a considerable change in the quantity consumers will buy

_____h. Change in price for a good or service not causing a considerable change in the quantity consumers will buy

1. Allocation
2. Inelastic demand
3. Economy
4. Elastic demand
5. Elasticity of demand
6. Economic system
7. Economics
8. Modified free enterprise system

2. Select from the following list major characteristics of the modified free enterprise system. Mark each correct answer with an "X."

_____a. Competition promotes efficient methods of production and improvements in goods and services

_____b. The producers' choice of what to buy determines the type and quantity of goods and services produced

_____c. Desire for profit is the primary motive for businesses and individuals ______d. Federal, state, and local governments control how the factors of production will be used

______e. Provides freedom of choice for employment and grants the right to own property and enter into contracts

______f. Existence of some monopolistic business is permitted

3. Discuss roles of the government in the economy.

   a. Producer and consumer of goods and services

   b. Regulator

4. Match economic goals of American people to correct descriptions. Write the correct numbers in the blanks provided.

______a. To have free choice in making economic decisions

______b. To use factors of production in the most efficient manner

______c. To have an ever-increasing standard of living

______d. To avoid ups and downs in the economy, such as inflation, recession, and depression

______e. To have a certain minimum standard of living

______f. To have fair distribution of the wealth of the nation based on productivity

1. Economic efficiency
2. Economic justice
3. Economic freedom
4. Economic growth
5. Economic stability
6. Economic security

5. Match factors of production to correct definitions. Write the correct numbers in the blanks provided.

_____a. Consists of such items as land, water, oil, natural gas, coal, and uranium

_____b. Investment in buildings and equipment used to produce goods and services

_____c. Develops ideas for goods and services; organizes and operates a business to produce or sell goods and services; makes decisions for a business; assumes risks for success or failure of a business

_____d. Physical and mental effort used in the production of goods and services

1. Capital
2. Labor
3. Land
4. Entrepreneur

6. Describe function of supply and demand.

a. Supply– ____________________

____

____

b. Demand– ____________________

____

____

c. Supply and demand– ____________________

____

____

7. List factors that determine the degree of elasticity of demand.

a. ____________________

b. ____________________

c. ____________________

8. Select from the following list factors of price that influence the economy. Mark each correct answer with an "X."

_____a. Price determines what will be produced by showing what goods and services are profitable

_____b. Individual buying decisions of consumers determine the price for goods and services ______c. Methods of production for a good or service is determined by price

______d. Allocation of scarce resources will be determined by price

______e. Decision of an individual about what good or service to buy is not influenced by price

______f. Price of goods and services determines what consumers are able to buy

______g. Marketing surveys and reviews of past sales records determine what goods and services consumers will buy and the price consumers will pay

9. Collect information on the role of government in the economy.

10. Analyze a supply and demand schedule.

11. Interpret factors of price that influence the economy.

(NOTE: If activities 9-11 have not been finished before the test, ask your instructor when they should be completed.)

ECONOMICS OF FREE ENTERPRISE
UNIT II

ANSWERS TO TEST

1. a. 8
   b. 3
   c. 6
   d. 7
   e. 1
   f. 5
   g. 4
   h. 2

2. a, c, e, f

3. Discussion should include:

   a. Producer and consumer of goods and services

      1) Federal government provides military defense, national parks and recreational facilities, interstate highways, social security, health care, postal service

      2) State government provides state and interstate highways; educational facilities; state parks and recreational facilities; state police protection; assistance to the aged, handicapped, and disadvantaged; health care

      3) Local government provides streets, water and sewage facilities, police and fire protection, libraries, health care

   b. Regulator

      1) Regulates and inspects goods and services

      2) Establishes and enforces employment standards

      3) Regulates business, particularly large businesses

4. a. 3
   b. 1
   c. 4
   d. 5
   e. 6
   f. 2

5. a. 3
   b. 1
   c. 4
   d. 2

6. Descriptions should include:
   a. Quantity of a good or service that producers are willing and able to make available for consumers to buy at a specific price and time
   b. Quantity of a good or service that consumers are willing and able to buy at a specific price and time
   c. Determines the price and number of goods or services that will be produced
7. a. Whether a good or service is a necessity or a luxury
   b. Availability of substitute products
   c. Amount of money consumers have available and are willing to spend
8. a, c, d, f, g
9. Evaluated to the satisfaction of the instructor
10. Evaluated to the satisfaction of the instructor
11. Evaluated to the satisfaction of the instructor

INDUSTRY ORIENTATION
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to list facts concerning the occupation and occupational outlook for equipment operators. The student should also be able to recognize different types of equipment and the major skills of operators. This knowledge will be shown by completion of assignment sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with industry orientation to the correct definitions.
2. List facts concerning occupational outlook for equipment operators.
3. Name employment opportunities for equipment operators.
4. Distinguish between advantages and disadvantages for heavy equipment operators.
5. State characteristics of a good equipment operator.
6. Name major skills involved in an equipment operator's program.
7. Match types of equipment to the correct basic uses.
8. Complete employment application.
9. Practice interview questions.
10. Compare job opportunities.

INDUSTRY ORIENTATION
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information and assignment sheets.

   E. Give test.

II. Instructional materials:

   A. Objective sheet

   B. Information sheet

   C. Assignment sheets

      1. Assignment Sheet #1--Complete Employment Application

      2. Assignment Sheet #2--Practice Interview Questions

      3. Assignment Sheet #3--Compare Job Opportunities

   D. Test

   E. Answers to test

III. Unit reference--*Occupational Outlook Handbook.* 1970 edition. U.S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 1650.

INDUSTRY ORIENTATION
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Equipment operators--Persons who operate heavy equipment

   B. Construction industry--Relating to crafts and skills of industrial and commercial construction

   C. Sub-contractor--Business firm which contracts part, or all, of another's obligations (third party)

   D. Equipment maintenance--Care of equipment

   E. Skills--Abilities gained by special experience

   F. Job--Work done in return for pay

   G. Consolidate--To make solid or compact

   H. Compact--Act of pressing material together to increase density

   I. Recycling--Process of reusing materials that would otherwise be destroyed

   J. Riprap--Mixture of stones combined to prevent erosion and make foundation more stable

II. Facts concerning occupational outlook for equipment operators

   A. Job opportunities result each year from the need to replace experienced operators who retire or die

   B. More and larger projects are constructed each year, requiring more operators

      Examples: Shopping centers, airports, high-rise buildings, water plants, sewage disposal plants, and highway systems

   C. Specialization creates more job opportunities and more desirable working conditions

   D. New designs and modern techniques make heavy equipment more desirable to operate

   E. New and larger equipment opens new fields in maintenance and repair

   F. Conservation and recycling creates more jobs

INFORMATION SHEET

III. Employment opportunities for equipment operators (Assignment Sheets #1, #2, and #3)

   A. Operators for independent and union-affiliated contractors

   B. Maintenance operators for large parking lots, airports, shopping centers, and city and state highway systems

   C. Mechanics for heavy equipment contractors

   D. Operators for salvage yards and recycling centers due to increased conservation

IV. Advantages and disadvantages for heavy equipment operators

   A. Advantages

      1. Good pay

      2. Work outside

      3. Variety of jobs

      4. Improvement of skills

         Example: Operating different types of equipment

      5. Increased job mobility

         (NOTE: Operator with several skills has opportunity to work in other geographic locations.)

      6. Comfortable work clothes

         (NOTE: Do not have to wear dress clothes.)

   B. Disadvantages

      1. Dirty

      2. Hazardous

         Examples: Dangerous areas--Blasting, steep slopes and swamps
         Dangerous to health--Back injuries and hemorrhoids; hearing and lung diseases

      3. Outdoor exposure

         Example: Hot in summer and cold in winter

INFORMATION SHEET

4. Loss of work due to bad weather

5. Have to wear safety equipment

   Examples: Safety glasses, dust respirators, safety shoes and hardhats

6. Travel away from home

V. Characteristics of a good equipment operator

(NOTE: It is impossible to cover every phase of safety and hazardous conditions; therefore, knowledge and adaptation to basic rules will help develop good and safe habits.)

A. Checks all equipment before starting work

B. Operates all equipment correctly

C. Is safety conscious and follows safety regulations

D. Takes instructions readily and follows company rules

E. Practices conservation of materials and equipment

F. Displays enthusiasm about job

G. Exhibits pride in the trade

H. Controls temper at all times

I. Is punctual

J. Is a good citizen

VI. Major skills involved in an equipment operator's program

A. Measuring

B. Math

C. Fuels, lubricants, and coolants

D. Rigging

E. Equipment maintenance/mechanics

F. Equipment operation

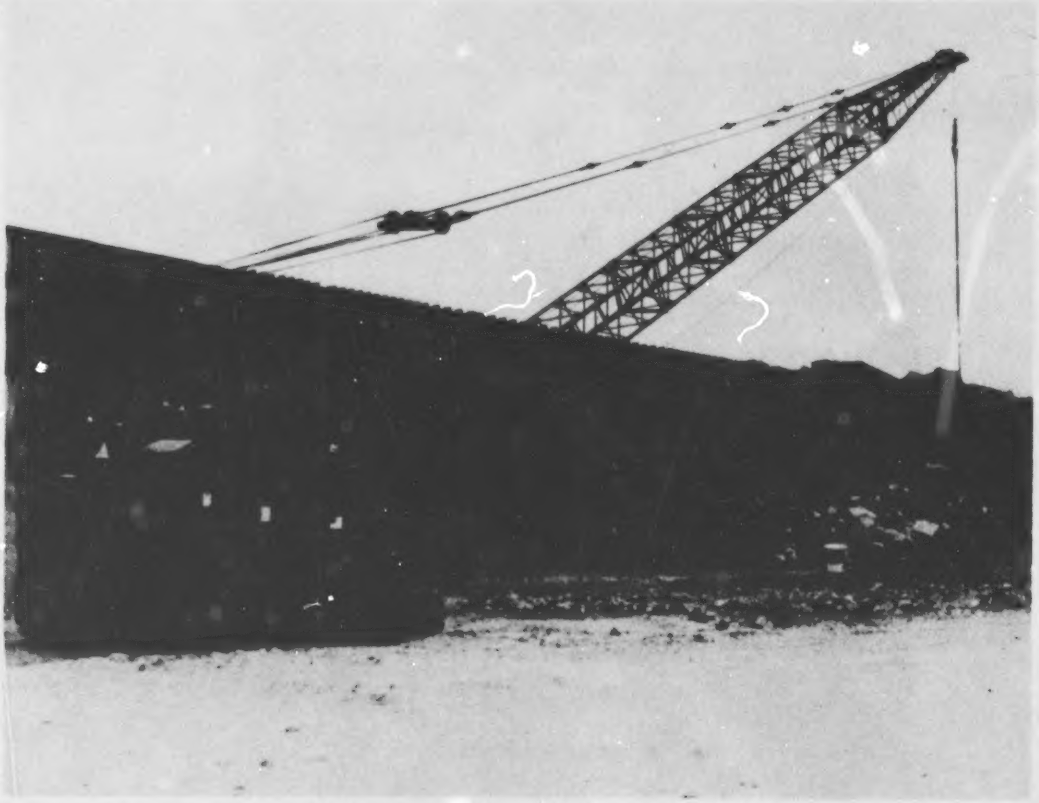
G. Welding/cutting

INFORMATION SHEET

VII. Basic uses of types of equipment

A. Crawler crane (wire rope)--Used for lifting

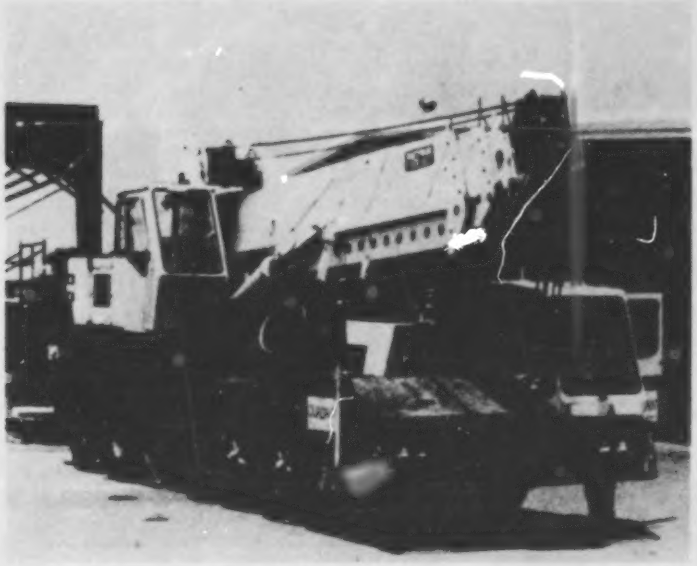
(NOTE: The basic function of a crawler crane is to lift, but it can perform numerous jobs when equipped with optional equipment.)



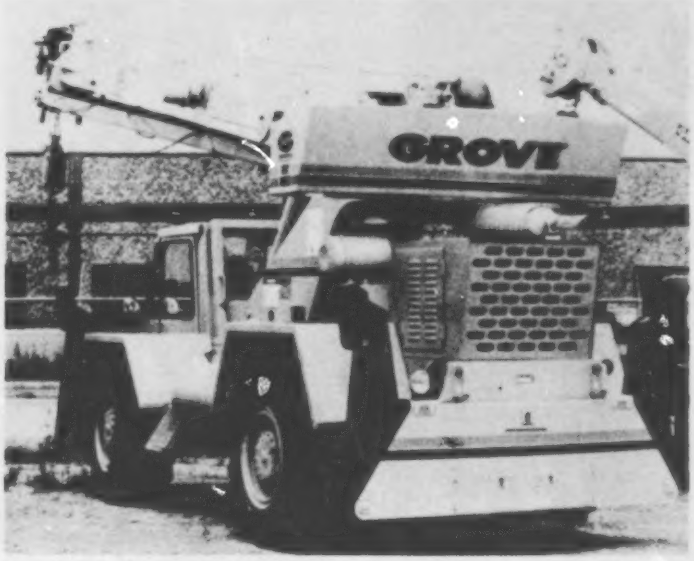
INFORMATION SHEET

B. Truck crane (hydraulic)--Used for lifting

(NOTE: Truck cranes are used extensively on construction jobs where mobility is important.)



C. Rough terrain crane--Used for lifting where the ground is very rough

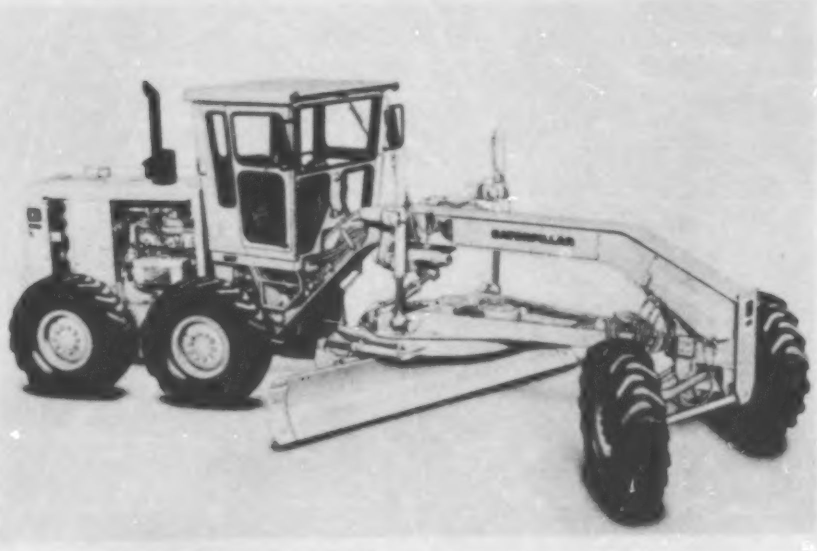


INFORMATION SHEET

D. Cherry picker--Used for precision lifting

(NOTE: Cherry pickers are favored by maintenance and utility companies because they can put the workers where they need to be.)

E. Grader--Used to shape and maintain roads, finish ditchings, and finish grading

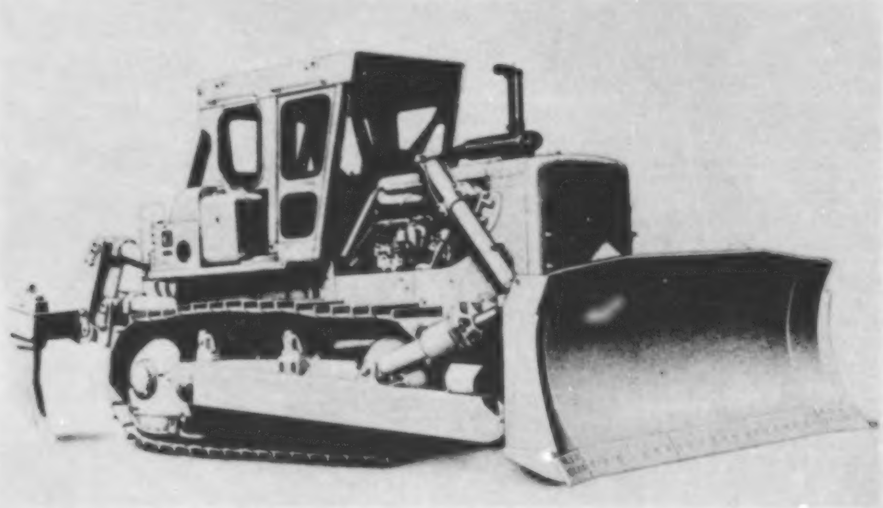


Used with permission of Caterpillar Tractor Co.

INFORMATION SHEET

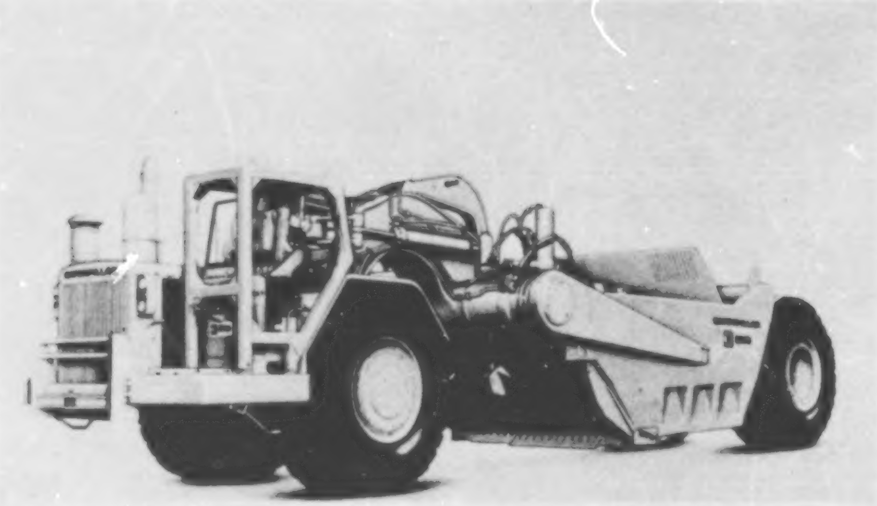
F. Tractor--Used to make cuts, strip soil, stockpile, and backfill

(NOTE: Tractors are used for various other jobs such as grading, sloping, push loading, bench building, and running a fill.)



Used with permission of Caterpillar Tractor Co.

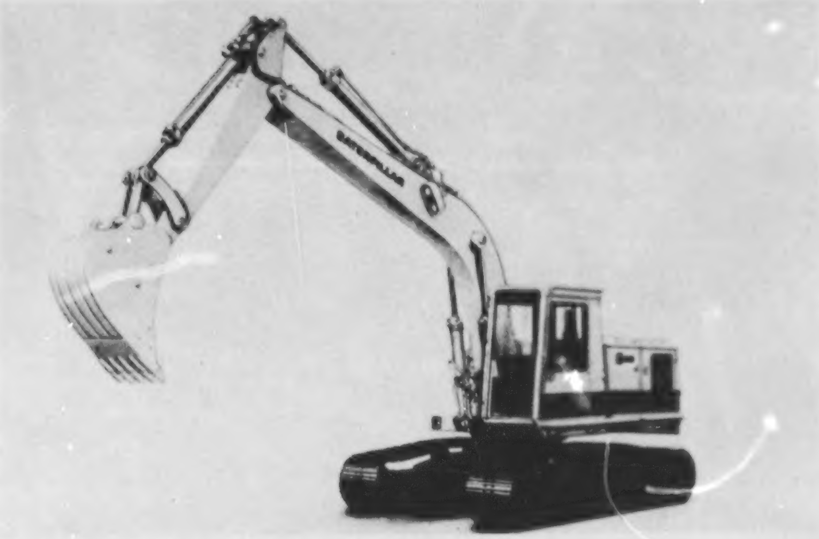
G. Scraper--Used to cut, load, collect loose material, haul, and spread



Used with permission of Caterpillar Tractor Co.

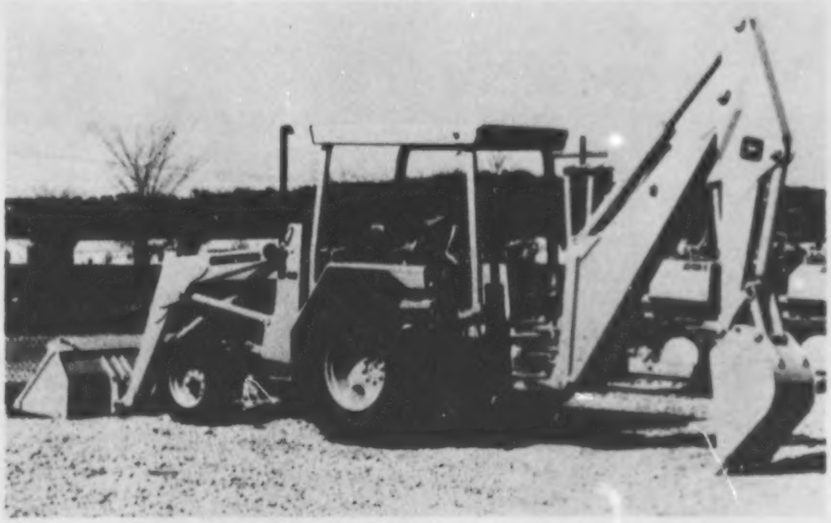
INFORMATION SHEET

H. Excavator (hydraulic)--Used for ditching, excavating, hoisting and demolition



Used with permission of Caterpillar Tractor Co.

I. Backhoe--Used for filling, backfilling, excavating, trenching, tree removal, placing riprap, and loading

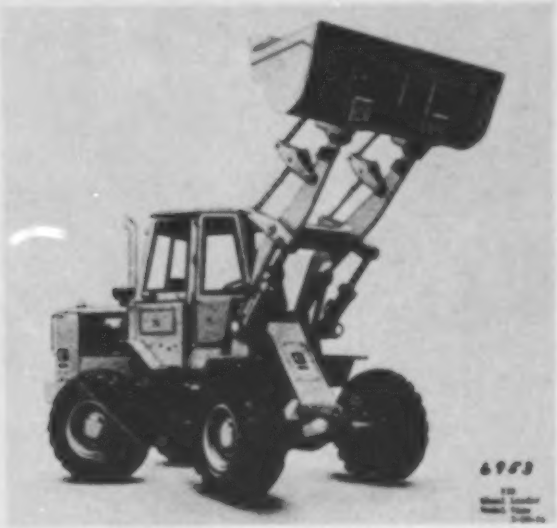


INFORMATION SHEET

J. Loader (high lift)--Used for precision and production loading of trucks and hoppers

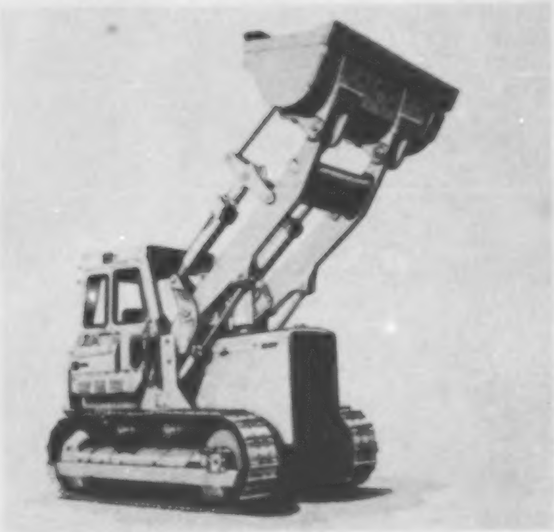
(NOTE: Quite often loading can be hazardous due to traffic, pedestrians, other equipment, and around blasting, especially in the mining industry.)

Wheel Loader



Used with permission of Caterpillar Tractor Co.

Crawler Loader



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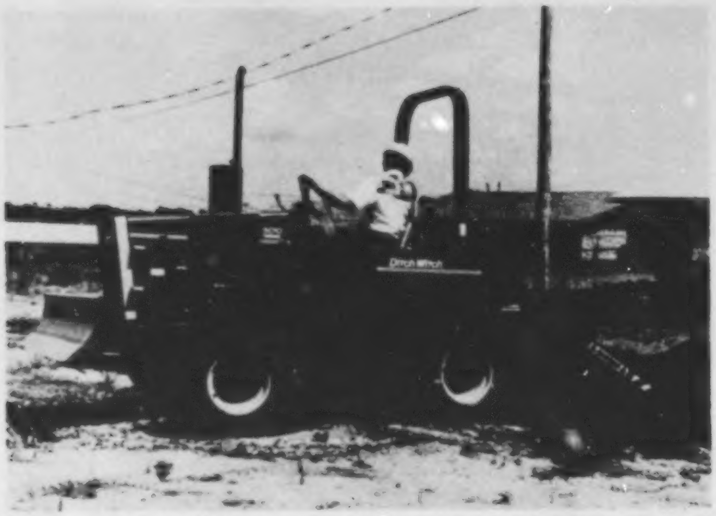
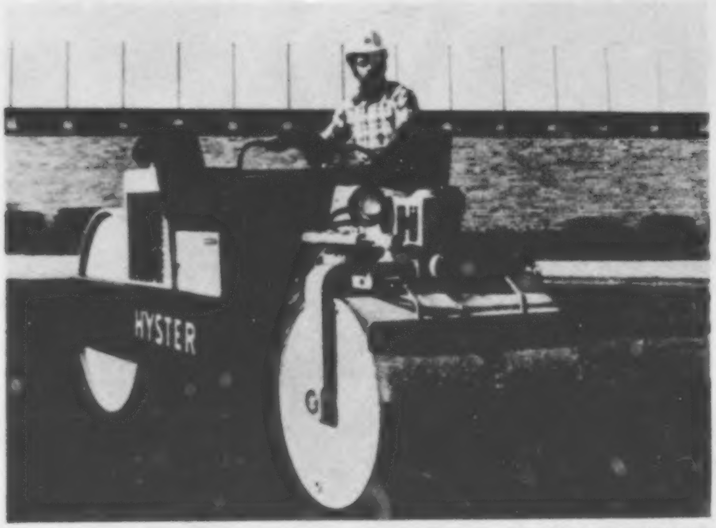
INFORMATION SHEET

K. Trencher--Used to dig trenches and/or ditches to specific line and grades



Model 5010 Ditch Witch® trencher, manufactured by The Charles Machine Works, Inc. Used with permission of The Charles Machine Works, Inc.

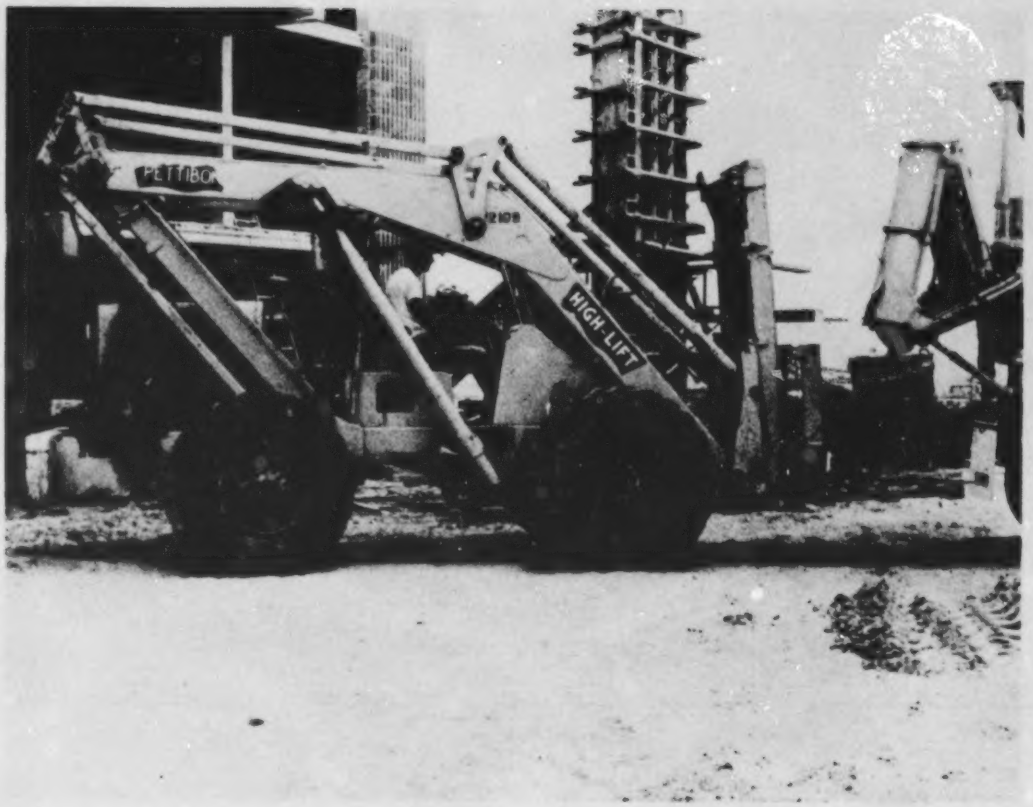
L. Roller--Used to compact and consolidate materials



Used with the permission of the Hyster Company, Construction Equipment Division.

INFORMATION SHEET

M. Forklift (rough terrain)--Usually used to haul and hoist materials on construction jobs


PETTIBO
HIGH-LIFT

INDUSTRY ORIENTATION
UNIT III

ASSIGNMENT SHEET #1--COMPLETE EMPLOYMENT APPLICATION

NAME________________________ SCORE____________

Complete the following application form using guidelines below and information about yourself.

(NOTE: Although each business uses its own form, general rules of preparation apply to any form.)

1. Be prepared.
    a. Take a good ink pen.
    b. Take copies of resumé.
2. Look over entire form before starting to write; do not hurry.
3. Follow directions.
    a. Note whether information is to be printed or written.
    b. Carry out all directions.
4. Write clearly, neatly, and legibly.
5. Answer briefly.
6. Be honest.
7. Answer all questions.

    (NOTE: If questions do not apply to you, write *NOT APPLICABLE* or *N/A* in the space to show that you did not overlook the question.)
8. Include complete information.
9. Recheck application when finished.
10. Avoid cross-outs and erasure marks.
11. Use the word open for questions about minimum salary since most employers pay standardized rates and will not negotiate on this.

ASSIGNMENT SHEET #1

HEO I - 81-A

"WE ARE AN EQUAL OPPORTUNITY EMPLOYMENT COMPANY. WE ARE DEDICATED TO A POLICY OF NON-DISCRIMINATION IN EMPLOYMENT ON ANY BASIS INCLUDING RACE, CREED, COLOR, AGE, SEX, RELIGION OR NATIONAL ORIGIN OR PHYSICAL DEFECTS."

APPLICATION FOR EMPLOYMENT

PERSONAL INFORMATION

DATE

NAME
LAST FIRST MIDDLE

PRESENT ADDRESS
STREET CITY STATE ZIP

PERMANENT ADDRESS
STREET CITY STATE ZIP

PHONE NO. SOCIAL SECURITY NUMBER

REFERRED BY

LAST

FIRST

MIDDLE

EMPLOYMENT DESIRED

POSITION

DATE YOU CAN START

SALARY DESIRED

RE YOU EMPLOYED NOW?

IF SO, MAY WE INQUIRE OF YOUR PRESENT EMPLOYER

EVER APPLIED TO THIS COMPANY BEFORE?

WHERE

WHEN

EDUCATION	NAME AND LOCATION OF SCHOOL	YEARS ATTENDED	DATE GRADUATED	SUBJECTS STUDIED
GRAMMAR SCHOOL				
HIGH SCHOOL				
COLLEGE				
TRADE, BUSINESS, OR CORRESPONDENCE SCHOOL				

SUBJECTS OF SPECIAL STUDY OR RESEARCH WORK

U.S. MILITARY OR
VAL SERVICE

RANK

PRESENT MEMBERSHIP IN NATIONAL GUARD OR RESERVES

TIVITIES OTHER THAN RELIGIOUS
(CIVIC, ATHLETIC, FRATERNAL, ETC.)

Exclude organizations, the name or character of which indicates the race, creed, color, or national origin of its members.

(CONTINUED ON OTHER SIDE)

82-A

ASSIGNMENT SHEET #1

FORMER EMPLOYERS (LIST BELOW LAST FOUR EMPLOYERS, STARTING WITH LAST ONE FIRST.)

DATE MONTH & YEAR	NAME AND ADDRESS OF EMPLOYER	SALARY	POSITION	REASON FOR LEAVING
FROM				
TO				
FROM				
TO				
FROM				
TO				
FROM				
TO				

REFERENCES: Give below the names of two persons not related to you, whom you have known at least one year.

	NAME	ADDRESS	BUSINESS	YEARS ACQUAINTED
1				
2				

PHYSICAL RECORD:

List any physical defects

WERE YOU EVER INJURED? GIVE DETAILS

HAVE YOU ANY DEFECTS IN HEARING? IN VISION? IN SPEECH?

IN CASE OF EMERGENCY NOTIFY

NAME ADDRESS PHONE NO.

I AUTHORIZE INVESTIGATION OF ALL STATEMENTS CONTAINED IN THIS APPLICATION. I UNDERSTAND THAT MISREPRESENTATION OR OMISSION OF FACTS CALLED FOR IS CAUSE FOR DISMISSAL. FURTHER, I UNDERSTAND AND AGREE THAT MY EMPLOYMENT IS FOR NO DEFINITE PERIOD AND MAY, REGARDLESS OF THE DATE OF PAYMENT OF MY WAGES AND SALARY, BE TERMINATED AT ANY TIME WITHOUT ANY PREVIOUS NOTICE.

DATE SIGNATURE

DO NOT WRITE BELOW THIS LINE

TO BE COMPLETED DAY EMPLOYMENT BEGINS DATE ________

HEIGHT WEIGHT AGE DATE OF BIRTH

SINGLE MARRIED WIDOWED CITIZEN U.S.A. SEX

THE ABOVE INFORMATION NEEDED FOR PENSION, HOSPITALIZATION, INSURANCE, ETC., AND NOT FOR HIRING PURPOSES

INTERVIEWED BY DATE REMARKS

NEATNESS		CHARACTER	
PERSONALITY		ABILITY	

HIRED FOR DEPT. POSITION WILL REPORT SALARY WAGES

APPROVED: 1. 2. 3.

EMPLOYMENT MANAGER DEPT. HEAD GENERAL MANAGER

INDUSTRY ORIENTATION
UNIT III

ASSIGNMENT SHEET #2--PRACTICE INTERVIEW QUESTIONS

NAME________________________________ SCORE______________

The following are some questions which might be asked when applying for a job. Keep the assignment sheet to review before going to an interview.

(NOTE: Questions about your personal life may not legally be asked. In fact, it is illegal for an employer to ask your maiden name or your father's surname if you are a female applicant; your marital status; who lives with you; the church you attend or the name of your spiritual leader; how many children you have, their ages, or who will care for them while you are at work; whether you own or rent your residence; whether you have ever had your wages garnisheed; and whether you have ever been arrested. However, many interviewers, particularly in smaller businesses, may ask such questions. Whether or not you choose to answer the questions depends on how badly you want the job.)

1. Why did you leave your previous job?

2. What did you like best about your job?

3. Are you in good health?

4. Do you intend to make this work your career?

5. What are some of your special abilities?

ASSIGNMENT SHEET #2

6. What equipment do you operate?

7. How would you rate your training for this job? Very good? Fair?

8. What personal characteristics do you think are needed to succeed in your vocation?

9. At what salary do you expect to start?

10. How could you contribute to our organization?

11. Why should we hire you?

12. Tell us about your family and any plans for marriage or further education.

(NOTE: REMEMBER--Legally, you do not have to answer this question. However, it is a good idea to have an answer.)

13. Have you applied for any other jobs?

ASSIGNMENT SHEET #2

14. Do you have any military obligations to fulfill?

15. Would you be able to work Saturdays and Sundays?

16. Does criticism disturb you?

17. Would you be willing to relocate?

18. What size city do you prefer?

19. Define *cooperation*.

20. How do you feel about working overtime?

REMEMBER: You never get a second chance to make a good first impression!!! GETTING A JOB IS A JOB!!!

INDUSTRY ORIENTATION
UNIT III

ASSIGNMENT SHEET #3--COMPARE JOB OPPORTUNITIES

NAME ______________________________ SCORE ______________

When you are offered a job or are changing jobs there are many factors to weigh before taking the position. Some of these include:

What is your take-home pay?

What are the benefits which accompany the job?

How much will it cost to actually be at work each day?

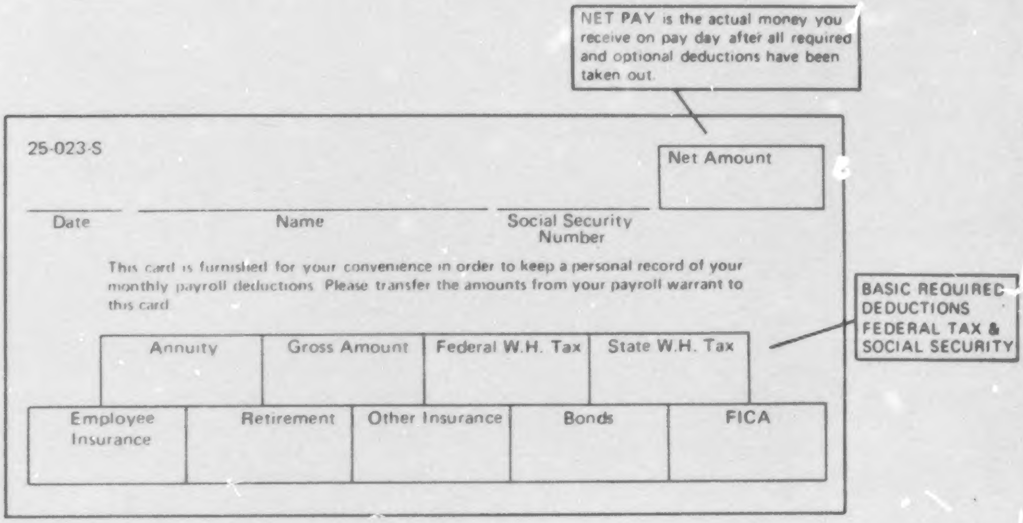
Would the job be satisfying to you?

How would the job meet your needs and aspirations?

WHAT'S MY TAKE-HOME PAY?

Salaries and wages are often quoted by employers as *gross earnings.* Gross earnings are used because tax deductions vary due to the number of dependents, the amount of earnings, and other information.

Optional benefits and deductions offered by an employer also differ. It is generally advisable to ask what programs are available as these can affect the actual money you receive on payday.



NET PAY is the actual money you receive on pay day after all required and optional deductions have been taken out.

25-023-S

Net Amount

Date ____ Name ____ Social Security Number ____

This card is furnished for your convenience in order to keep a personal record of your monthly payroll deductions Please transfer the amounts from your payroll warrant to this card

	Annuity	Gross Amount	Federal W.H. Tax	State W.H. Tax
Employee Insurance	Retirement	Other Insurance	Bonds	FICA

BASIC REQUIRED DEDUCTIONS FEDERAL TAX & SOCIAL SECURITY

ASSIGNMENT SHEET #3

WHAT OTHER BENEFITS DO I GET FROM THE JOB?

Some benefits associated with working are not always visible. Often some of these overlooked benefits are paid for in part by your employer. At the time of the interview or when considering a position ask about:

- Employer's contributions for your protection which may include:
    - Health insurance
    - Unemployment compensation
    - Clothing and safety garments
    - Medical facilities and health tests
    - Pensions
    - Travel insurance (covering mishaps when traveling on business)
    - Educational programs or reimbursement for courses related to job
- Sick leave with pay
- Paid vacations and holidays

WHAT WILL IT COST TO WORK AT THIS JOB?

Frequently, we often overlook the costs which are associated with being employed. It may be of value to calculate estimated weekly expenses before you make a decision about a job.

Estimate weekly expenses for:

Transportation (parking, bus fares)	$_____	Child care for working parent	$_____
Lunches (or cost of food eaten away from home, including soft drinks and coffee)	$_____	Gifts for other employees	$_____
Clothing (including cleaning)	$_____	Special uniforms, materials, or equipment for job	$_____
		Other	$_____
		TOTAL	$_____

ASSIGNMENT SHEET #3

WHAT IS IMPORTANT TO ME IN A JOB?

Take-home pay and benefits may be only part of what you want from a job. Think through other things you consider important in a job.

What are some of the most rewarding things you've felt about any job you've ever had?

1. ______________________________
2. ______________________________
3. ______________________________

How might you rate these in order of what's important to you?

_____ Job security (little chance you'll be released from the job)

_____ Opportunity for advancement

_____ Recognition for your work

_____ Good wages

_____ Opportunity to learn and use your ideas

_____ Flexible working hours

_____ Long vacations

_____ Pleasant working conditions

_____ Interesting work

_____ Friendly co-workers

_____ Other, such as ______________________________

ARE YOU READY TO DECIDE????

Take all the information you have gathered and summarize it below and on the next page to reach a decision about whether you want the job or not.

1. Would the job be satisfying to you? Why/why not?

____

____

____

ASSIGNMENT SHEET #3

2. What are the benefits which accompany the job?

3. How much will it cost to actually be at work each day?

4. How would the job meet your needs and aspirations?

5. I estimate my take-home pay to be $__________.

6. I estimate my expenses related to working to be $____________.

7. I would most enjoy the following about this job:____________________________

8. I estimate my job benefits to be worth $____________.

INDUSTRY ORIENTATION
UNIT III

TEST

NAME________________________________ SCORE_______________

1. Match terms associated with industry orientation to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Persons who operate heavy equipment

_____b. Relating to crafts and skills of industrial and commercial construction

_____c. Business firm which contracts part, or all, of another's obligations (third party)

_____d. Care of equipment

_____e. Abilities gained by special experience

_____f. Work done in return for pay

_____g. To make solid or compact

_____h. Act of pressing material together to increase density

_____i. Process of reusing materials that would otherwise be destroyed

_____j. Mixture of stones combined to prevent erosion and make foundation more stable

1. Sub-contractor
2. Job
3. Construction industry
4. Consolidate
5. Equipment operators
6. Skills
7. Compact
8. Recycling
9. Equipment maintenance
10. Riprap

2. List four facts concerning occupational outlook for equipment operators.

a. ____

____

b. ____

____

c. ____

____

d. ____

____

3. Name three employment opportunities for equipment operators.

a. ______________________________

____

b. ______________________________

____

c. ______________________________

____

4. Distinguish between advantages and disadvantages for heavy equipment operators. Write an "A" before advantages and a "D" before disadvantages in the blanks provided.

_____a. Hazardous

_____b. Variety of jobs

_____c. Good pay

_____d. Comfortable work clothes

_____e. Loss of work due to bad weather

_____f. Work outside

_____g. Outdoor exposure

_____h. Improvement of skills

_____i. Have to wear safety equipment

_____j. Increased job mobility

_____k. Travel away from home

5. State five characteristics of a good equipment operator.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

6. Name major skills involved in an equipment operator's program.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

7. Match types of equipment to the correct basic uses. Write the correct numbers in the blanks provided. (A blank may have more than one correct answer.)

______a. Usually used to haul and hoist materials on construction jobs

______b. Used to compact and consolidate materials

______c. Used for ditching, excavating, hoisting, and demolition

______d. Used to dig trenches and/or ditches to specific line and grades

e. Used for lifting

______f. Used for fillling, backfilling, excavating, trenching, tree removal, placing riprap, and loading

______g. Used to shape and maintain roads, finish ditchings, and finish grading

______h. Used to make cuts, strip soil, stockpile, and backfill

______i. Used for precision lifting

______j. Used to cut, load, collect loose material, haul, and spread

______k. Used for precision and production loading of trucks and hoppers

______l. Used for lifting where the ground is very rough

1. Crawler crane (wire rope)
2. Grader
3. Cherry picker
4. Truck crane (hydraulic)
5. Tractor
6. Scraper
7. Excavator (hydraulic)
8. Backhoe
9. Loader (high lift)
10. Trencher
11. Roller
12. Forklift (rough terrain)
13. Rough terrain crane

8. Complete employment application.
9. Practice interview questions.
10. Compare job opportunities.

(NOTE: If activities 8-10 have not been finished before the test, ask your instructor when they should be completed.)

INDUSTRY ORIENTATION
UNIT III

ANSWERS TO TEST

1. a. 5
   b. 3
   c. 1
   d. 9
   e. 6
   f. 2
   g. 4
   h. 7
   i. 8
   j. 10

2. Any four of the following:
   a. Job opportunities result each year from the need to replace experienced operators who retire or die
   b. More and larger projects are constructed each year, requiring more operators
   c. Specialization creates more job opportunities and more desirable working conditions
   d. New designs and modern techniques make heavy equipment more desirable to operate
   e. New and larger equipment opens new fields in maintenance and repair
   f. Conservation and recycling creates more jobs

3. Any three of the following:
   a. Operators for independent and union-affiliated contractors
   b. Maintenance operators for large parking lots, airports, shopping centers, and city and state highway systems
   c. Mechanics for heavy equipment contractors
   d. Operators for salvage yards and recycling centers due to increased conservation

4. a. D
   b. A
   c. A
   d. A
   e. D
   f. A
   g. D
   h. A
   i. D
   j. A
   k. D

5. Any five of the following:
    - a. Checks all equipment before starting work
    - b. Operates all equipment correctly
    - c. Is safety conscious and follows safety regulations
    - d. Takes instructions readily and follows company rules
    - e. Practices conservation of materials and equipment
    - f. Displays enthusiasm about job
    - g. Exhibits pride in the trade
    - h. Controls temper at all times
    - i. Is punctual
    - j. Is a good citizen
6. a. Measuring
    - b. Math
    - c. Fuels, lubricants, and coolants
    - d. Rigging
    - e. Equipment maintenance/mechanics
    - f. Equipment operation
    - g. Welding/cutting
7. a. 12
    - b. 11
    - c. 7
    - d. 10
    - e. 1, 4
    - f. 8
    - g. 2
    - h. 5
    - i. 3
    - j. 6
    - k. 9
    - l. 13
8. Evaluated to the satisfaction of the instructor
9. Evaluated to the satisfaction of the instructor
10. Evaluated to the satisfaction of the instructor

SAFETY AND FIRST AID
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to practice personal and general job safety while performing duties. This knowledge will be evidenced by completion of assignment sheets, job sheets, and unit test with a minimum of 100 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with safety and first aid to the correct definitions.
2. State reasons for practicing job safety.
3. Match the colors of the safety color code to the correct applications.
4. State personal safety rules.
5. State rules for general job safety.
6. Select from a list the components of the fire triangle.
7. Match classes of fires to the correct descriptions.
8. Match types of fire extinguishers to the classes of fire for which each is used.
9. Describe procedures used to maintain a clean and orderly work area.
10. Describe procedures used to lift heavy objects correctly.
11. State safety rules concerning flammable liquids.
12. Name reasons why knowledge of first aid is important.
13. Discuss reasons why first aid skills are needed.
14. Arrange in order immediate steps to follow when giving first aid to an accident victim.
15. Select from a list factors to consider in first aid treatment of shock.
16. Classify burns by degree according to their description.
17. Match first, second, and third degree burns to their correct first aid treatment.

18. Describe steps to follow to control bleeding by direct pressure.
19. Arrange in order steps to follow for mouth-to-mouth resuscitation.
20. Complete a safety pledge form.
21. Analyze accident case studies.
22. Demonstrate the ability to:
    a. Give mouth-to-mouth resuscitation.
    b. Show proper way to lift.

SAFETY AND FIRST AID
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Make transparencies.

   C. Provide student with information, assignment, and job sheets.

   D. Discuss unit and specific objectives.

   E. Discuss information and assignment sheets.

   F. Demonstrate and discuss procedures outlined in job sheets.

   G. Contact a safety engineer as a resource person for class concerning safety on the job.

   H. Have students complete a first-aid course and be certified according to OSHA regulations.

   I. Have students demonstrate the ability to practice safety and first aid in accordance to the Eight Hour First Aid and Safety Standards set up by MSHA and OSHA safety standards.

   J. Give test.

II. Instructional materials:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--The Fire Triangle

      2. TM 2--Types of Fire Extinguishers

      3. TM 3--Correct Way to Lift Heavy Objects

   D. Assignment sheets

      1. Assignment Sheet #1--Complete a Safety Pledge Form

      2. Assignment Sheet #2--Analyze Accident Case Studies

   E. Answers to assignment sheets

   F. Job sheets

      1. Job Sheet #1--Give Mouth-to-Mouth Resuscitation
      2. Job Sheet #2--Show Proper Way to Lift

- G. Test
- H. Answers to test

III. Unit references:

- A. Smith, Earl. *Power Line Technician.* Stillwater: Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1978.
- B. *Rubber-Tired Front End Loader and Forklift Truck Accident Prevention.* Mesa Instruction Guide 30. Washington, D.C.: United States Department of the Interior, Mining Enforcement and Safety Administration, 1975.
- C. Hendrix, Laborn J., "Bud." *Millwright Instructional Materials.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.
- D. *First Aid.* Washington, D.C.: United States Department of Labor, Bureau of Mines, 1978.
- E. *Accident Prevention Manual for Industrial Operations.* 7th ed. National Safety Council, 444 N. Michigan Avenue, Chicago, Illinois, 1974.

IV. Films:

- A. *Housekeeping Means Safekeeping.* Color, 10 min., Journal Films, Inc., 1975. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.
- B. *Stop a Fire Before It Starts.* Color, 10 min., Journal Films, Inc., 1975. Available from Journal Films, Inc., 930 Pitner Avenue, Evanston, Illinois 60202.
- C. *A New Way to Lift.* Color, 9 min., Journal Films, Inc., 1970. Available from Journal Films, Inc., 930 Pitner Ave., Evanston, Illinois 60202.
- D. *It Always Happens to the Other Guy.* Color, 21 min., Modern Talking Picture Service, 1980. Available from Modern Talking Picture Service, 45 Rockefeller Plaza, New York, NY 10020.
- E. *The Industrial Weight Lifter.* Color, 12 min., Ruddel Films for Industrial Accident Prevention Association Ontario and Canada Packers Ltd., 1965. Available from International Film Bureau Inc., 332 South Michigan Ave., Chicago, Illinois 60604.

SAFETY AND FIRST AID
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Safety--State or condition of being safe; freedom from danger, risk, or injury

B. Accident--Any suddenly occurring, unintentional event which causes injury or property damage

C. First aid--Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

D. Occupational Safety and Health Act (OSHA)--Federal legislation designed to ensure safe and sanitary working conditions for employees

E. Flammable--Capable of being easily ignited and burning with extreme rapidity

F. Explosive--Something tending to explode

G. Combustible--Capable of bursting into flames

H. Radiation--Combined processes of emission, transmission, and absorption of radiant energy

I. Extinguish--To cause to cease burning

J. Pressurized--Container in which a liquid is stored under pressure greater than the pressure of the atmosphere

K. Solvent--Liquid substance capable of dissolving or dispersing one or more other substances

L. Pneumatic--Air-powered

M. Hazard--Source of danger

N. Sloping--Tilted; at an angle

O. Tramming--Moving of any self-propelled equipment

P. Resuscitation--Act of bringing one back to full consciousness

Q. MSHA--Mine Safety and Health Administration

INFORMATION SHEET

II. Reasons for practicing job safety

- A. Prevent physical harm to yourself and others
- B. Avoid loss of work
- C. Avoid possible loss of pay
- D. Lower cost to employer
- E. Prevent loss or damage of equipment or materials
- F. Lower insurance rates
- G. Prevent hardship on family
- H. Provide regular job schedules
- I. Prevent possible loss of job

III. Colors and applications of the safety color code

- A. Federal safety red
  1. Designates danger
  2. Identifies fire protection equipment and its location
  3. Identifies portable containers of flammable liquids
  4. Identifies emergency stop bars, stop buttons, and emergency electrical stop switches on machinery
- B. Federal safety yellow
  1. Designates caution and marks physical hazards
  2. Designates waste containers for explosive or combustible materials
  3. Designates caution against starting, using, or moving equipment while under repair, or against the use of defective equipment
  4. Identifies the starting point or power source of machinery
- C. Federal safety orange
  1. Designates dangerous parts of equipment which may cut, crush, shock, or otherwise injure

INFORMATION SHEET

2. Designates safety starter buttons and parts of equipment that may cause electrical shock

3. Designates exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

D. Federal safety purple--Designates radiation hazards

E. Federal safety green

1. Designates location of safety equipment

2. Designates location of first-aid equipment

(NOTE: This applies to equipment other than fire-fighting equipment.)

F. Federal safety black and white (used individually or in combination)

1. Designates traffic flow

2. Designates housekeeping purposes

3. Designates storage areas

IV. Personal safety rules (Assignment Sheet #1)

A. Wear clothing that is appropriate for the activity being performed

B. Confine long hair before operating equipment

C. Wear safety glasses, suitable hard hats, goggles, and respiratory equipment, where required

D. Remove ties and loose sleeves when working around machine tools or rotating equipment

E. Remove rings and other jewelry when working

F. Be alert and conduct yourself in a manner to ensure safe practices

G. Use soap and water frequently as a method of preventing skin disease

H. Do not jump onto or off of moving equipment

I. Be familiar with location of first-aid equipment

INFORMATION SHEET

V. Rules for general job safey

  A. Keep all tools sharp, clean, and in safe working order

  B. Retain guards and safety devices on all equipment

  C. Report defective tools, machines, or other equipment to the supervisor

  D. Report all accidents to the supervisor, regardless of nature or severity

  E. Be sure machine and equipment operators turn off power and do not leave until equipment has stopped

  F. Disconnect power lock and tag out machine tools before performing maintenance

  G. Use correct, properly fitting wrenches on nuts and bolts

  H. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it

  I. Clean up any spilled liquids immediately

  J. Keep work area clear of scraps and litter

  K. Store oily rags and waste in proper containers

  L. Do not use compressed air to clean yourself or your clothing

  M. Be conscious of others' safety

  N. Be sure others are at a safe distance when operating moving equipment

  O. Use barricades and flaggers where required

  P. Maintain all safety rules and limitations on heavy equipment according to specifications and manufacturer's regulations

VI. Components of the fire triangle (Transparency 1)

(NOTE: To produce fire, these three elements are necessary and must be present at the same time. If any one of the three is missing, a fire cannot be started. With the removal of any one of the three, the fire will be extinguished.)

  A. Fuel

  (NOTE: This is any flammable material.)

INFORMATION SHEET

B. Heat

(NOTE: There has to be enough heat to raise the fuel to its ignition temperature.)

C. Oxygen

(NOTE: This is necessary to sustain combustion.)

VII. Classes of fires

A. Class A--Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish

B. Class B--Fires that occur with flammable liquids, such as gasoline, oil, grease, paint, and thinners

C. Class C--Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring

(CAUTION: Do *not* use pressurized water.)

D. Class D--Fires that occur with combustible metals, such as iron or magnesium

VIII. Types of fire extinguishers to use on classes of fires (Transparency 2)

A. Pressurized water--Used on Class A fires *only*

B. Soda acid--Used on Class A fires

C. Carbon dioxide (CO_2)--Used on Class B and C fires

D. Dry chemical--Used on Class B, C, and D fires

(NOTE: On Class D fires, dry sand is as effective as any dry chemical. There are other more highly refined chemical fire extinguishers, but their cost places them out of reach of most companies.)

E. Foam--Used on Class A and B fires

F. Multipurpose dry chemical--Used on Class A, B, and C fires

G. Water pump tank--Used on Class A fires only

IX. Procedures used to maintain a clean and orderly work area

A. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning

B. Stock materials and supplies in the proper places

INFORMATION SHEET

C. Store tools and accessories in cabinets, on racks, or other suitable devices

D. Clear work areas of debris and other hazards

E. Clean slippery substances from floor

F. Dispose of combustible materials properly

Example: Store oily rags in self-closing or spring-lid metal containers

G. Keep brooms, brushes, and other housekeeping equipment where it is readily available

X. Correct way to lift heavy objects (Transparency 3, Job Sheet #2)

A. Step up to object with feet apart; place one foot beside object and one behind

B. Lift with legs and not with the back

C. Keep back straight, nearly vertical

D. Tuck chin in

E. Grasp object with whole hand

F. Tuck elbows and arms in

G. Hold load close to body

H. Keep body weight directly over feet

(NOTE: Know your own physical capabilities and limits.)

XI. Safety rules concerning flammable liquids

A. Know the location and use of fire extinguishers for flammable liquids

B. Store all flammable liquids in approved safety containers

C. Use only approved cleaning solvents to clean parts

(CAUTION: DO NOT use gasoline.)

D. Do not operate an engine that is leaking gasoline

E. Change oil or gasoline-soaked clothing immediately

F. Do not fuel a running gasoline engine

INFORMATION SHEET

XII. Reasons why knowledge of first aid is important

- A. May mean the difference between life and death
- B. May mean the difference between temporary and permanent injuries
- C. Trains one in what to do and what not to do in an emergency

XIII. Reasons why first aid skills are needed

- A. Accidents are the number one cause of death
- B. There may not be time to wait for professional medical help after an accident
- C. Safety awareness needs to be promoted at work

XIV. Immediate steps to follow when giving first aid to an accident victim

(NOTE: These steps are important not only because they may help the victim, but also because the information learned must be reported accurately when you call for professional medical help.)

A. Observe overall emergency

(NOTE: Find out exactly what happened as quickly as possible because this will prepare you in examining the victim and in determining what to do first.)

B. Check breathing

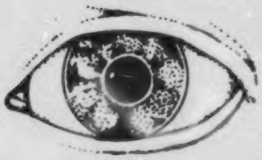
(NOTE: Check by laying your hand on victim's chest and holding your ear to victim's nose and mouth.)

C. Check pulse or heartbeat

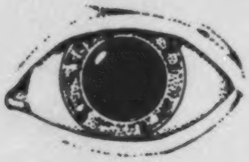
(NOTE: Pulse in wrist may be reduced, so check pulse in neck or groin.)

D. Observe pupil reactions of the eyes

(NOTE: Pupils may be constricted or dilated.)



Constricted



Dilated

INFORMATION SHEET

E. If victim is conscious, check alertness level by asking questions about physical status

F. Begin definite first aid treatment for symptoms

(NOTE: If you are not sure of symptoms and/or cause of emergency, do not move the victim. Keep victim quiet, warm, and do not give anything to drink or eat.)

XV. First aid treatment of shock

(NOTE: Shock may be caused by the loss of any body fluid resulting from prolonged conditions, severe injuries, infection, heart attack or stroke, poisoning from different sources, and the lack of oxygen. Shock may also be caused by metabolic disorders, such as diabetes.)

A. Keep victim lying down

B. Maintain adequate supply of oxygen

C. Cover victim to prevent loss of body heat and to stabilize blood circulation

D. Use good judgment in giving fluids; consider the victim's condition and the cause of shock

(NOTE: Give only a few sips at a time and give no alcoholic beverages. If there is a danger of choking or vomiting, do not give any fluids.)

E. Get medical help as soon as possible

XVI. Types of burns

A. First degree burns

(NOTE: First degree burns can be caused by sunburn, light contact with hot objects [accidentally touching a hot engine component], or contact with hot water or scalding steam [radiator].)

1. Redness or discoloration
2. Mild swelling and pain
3. Rapid healing

B. Second degree burns

(NOTE: Second degree burns can be caused by contact with hot liquids [boiling radiator water, hot tar or asphalt, battery acid], or a deep sunburn.)

1. Pain greater than first degree
2. Damage extending into the first layer of tissue

INFORMATION SHEET

3. Mottled or red areas

4. Blistering

5. Considerable swelling

6. Wet appearance of burned area due to loss of plasma

C. Third degree burns

(NOTE: Third degree burns can be caused by flame, ignited clothing, contact with hot objects, acid, electricity, or immersion in hot water.)

1. Deep tissue destruction

2. Less pain due to nerve destruction

   (NOTE: Pain may be greatly diminished because nervous tissue has been burned.)

3. Charred or a white-casted appearance

XVII. First aid treatment of first, second, and third degree burns

(NOTE: When assessing burns, it is wise to look at the percentage of the body burned and the areas injured to determine treatment.)

A. First degree--Apply cold water or submerge burned area in cold water; apply a dry dressing if necessary

B. Second degree--Submerge the part in cold but not ice water until pain eases; blot dry gently and apply dry, sterile dressings; do not break blisters, and do not use any ointments, sprays, or home remedies on burned area

C. Third degree--Cover burns with thick sterile dressings, but do not immerse in water; do not remove any tissue or burned clothing; transport victim to hospital as quickly as possible

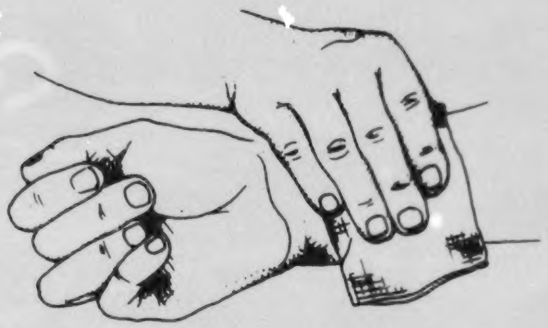
XVIII. First aid steps to follow to control bleeding by direct pressure

(NOTE: A victim may suffer shock and loss of consciousness from loss of blood. Because it is possible to bleed to death in a very short period of time, bleeding should be brought under control as soon as possible.)

INFORMATION SHEET

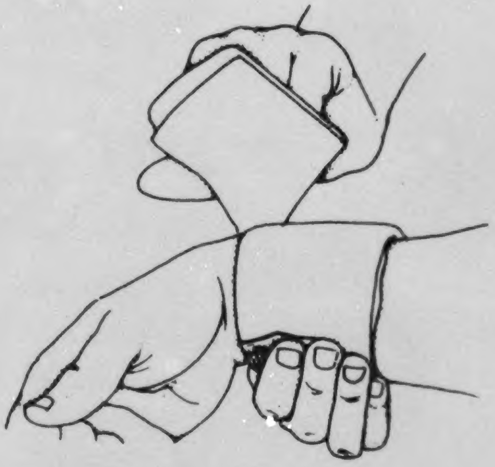
A. Apply dressing (prepared gauze, clean handkerchief, clean articles of clothing) to area, using firm pressure with hand

(NOTE: In some cases the bare hand has to be used until a suitable dressing or compress can be found.)



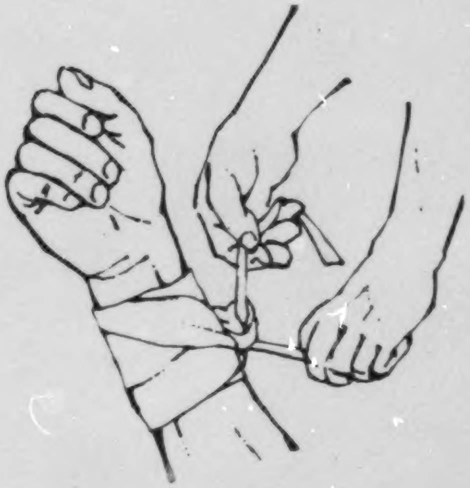
B. Check frequently to see if bleeding has stopped or slowed

(CAUTION: *Do not* disturb clots after they have formed. If blood soaks through cloth, do not remove, but add more layers or dressing.)



INFORMATION SHEET

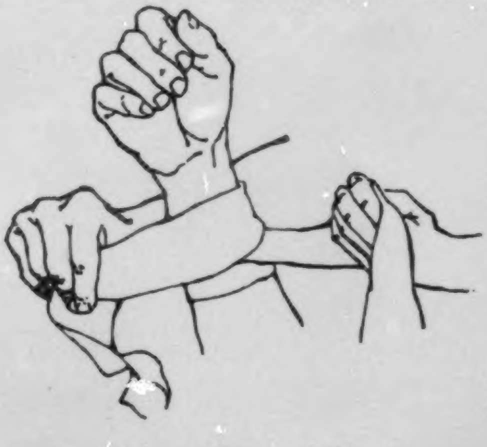
C. If bleeding is still active, apply a pressure bandage by holding the dressing in place with one hand, wrapping bandage directly over and around the injured area, and tying the knot over the wounded area



(NOTE: Use firm motion but do not wrap too tightly or circulation will be impaired.)

D. Elevate the limb, if possible, above the level of the victim's heart

(NOTE: This can be done if no apparent fracture has occured in that limb.)

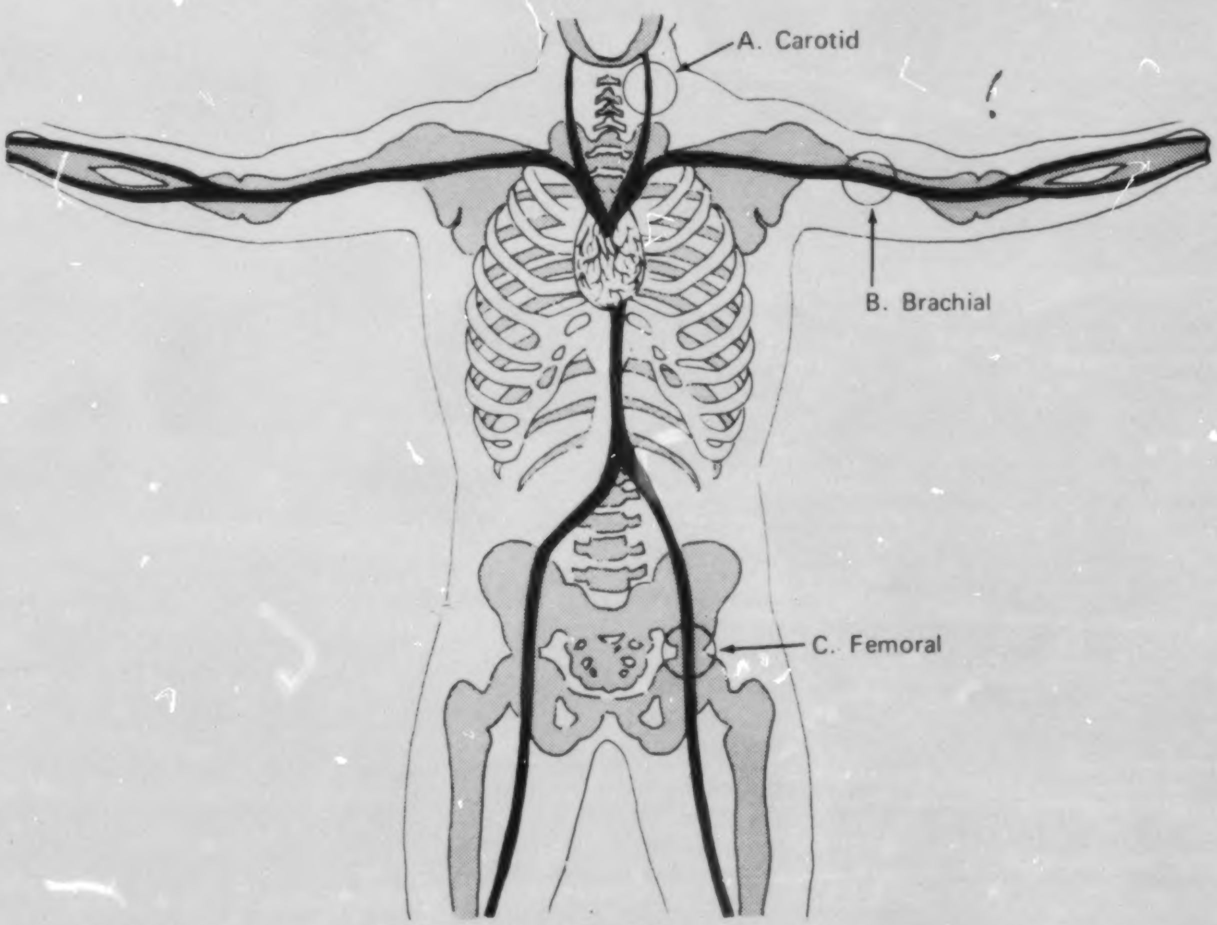


INFORMATION SHEET

E. If bleeding continues, apply pressure on the main artery that supplies blood to the injured area

(NOTE: Refer to the following diagram for pressure points to control bleeding in various areas.)

Example:



(CAUTION: Apply a tourniquet ONLY AS A LAST RESORT. A tourniquet may be necessary to save the victim's life, but it should be remembered that a tourniquet cuts off circulation and may cost the victim his or her limb. If you must use a tourniquet, MAKE SURE that the victim is seen by a physician as soon as possible.)

INFORMATION SHEET

XIX. First aid steps to follow for mouth-to-mouth resuscitation (Job Sheet #1)

A. Clear the air passage

B. Extend chin by lifting up under neck

C. Pinch nostrils together

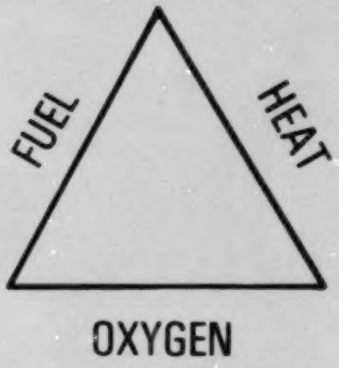
D. Inhale deeply; breathe into victim's mouth

E. Remove mouth from victim's mouth; listen for return flow of air

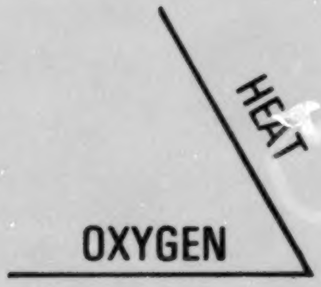
(NOTE: Continue this procedure until the victim is revived or until it is no longer necessary.)

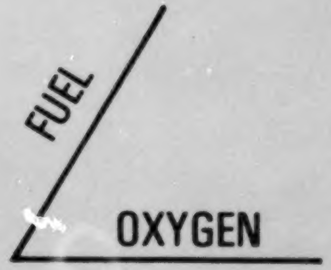
The Fire Triangle

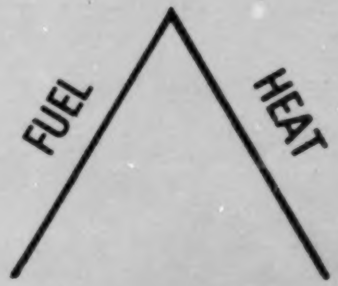
To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

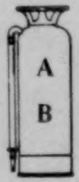
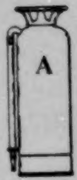
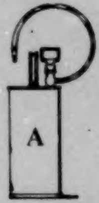
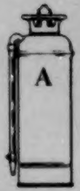
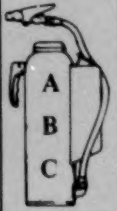
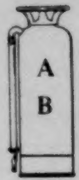
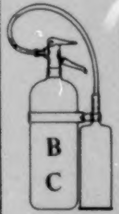
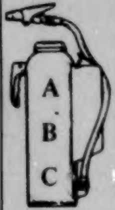
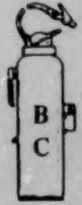
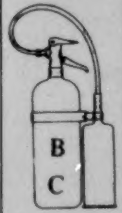
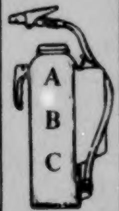
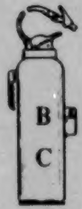
If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
OXYGEN


FUEL
OXYGEN



Types of Fire Extinguishers

KIND OF FIRE		APPROVED TYPE OF EXTINGUISHER						
		MATCH UP PROPER EXTINGUISHER WITH CLASS OF FIRE SHOWN AT LEFT Important! Using the wrong type extinguisher for the class of fire may be dangerous.						
DECIDE THE CLASS OF FIRE YOU ARE FIGHTING...	...THEN CHECK THE COLUMNS TO THE RIGHT OF THAT CLASS	**FOAM** Solution of Aluminum Sulphate and Bicarbonate of Soda	**CARBON DIOXIDE** Carbon Dioxide Gas Under Pressure	**SODA ACID** Bicarbonate of Soda Solution and Sulphuric Acid	**PUMP TANK** Plain Water	**GAS CARTRIDGE** Water Expelled by Carbon Dioxide Gas	**MULTI-PURPOSE DRY CHEMICAL**	**ORDINARY DRY CHEMICAL**
A	**CLASS A FIRES Use These Extinguishers** **ORDINARY COMBUSTIBLES** • Wood • Paper • Cloth, Etc.							
B	**CLASS B FIRES Use These Extinguishers** **FLAMMABLE LIQUIDS, GREASE** • Gasoline • Paints • Oils, Etc.							
C	**CLASS C FIRES Use These Extinguishers** **ELECTRICAL EQUIPMENT** • Motors • Switches, Etc.							

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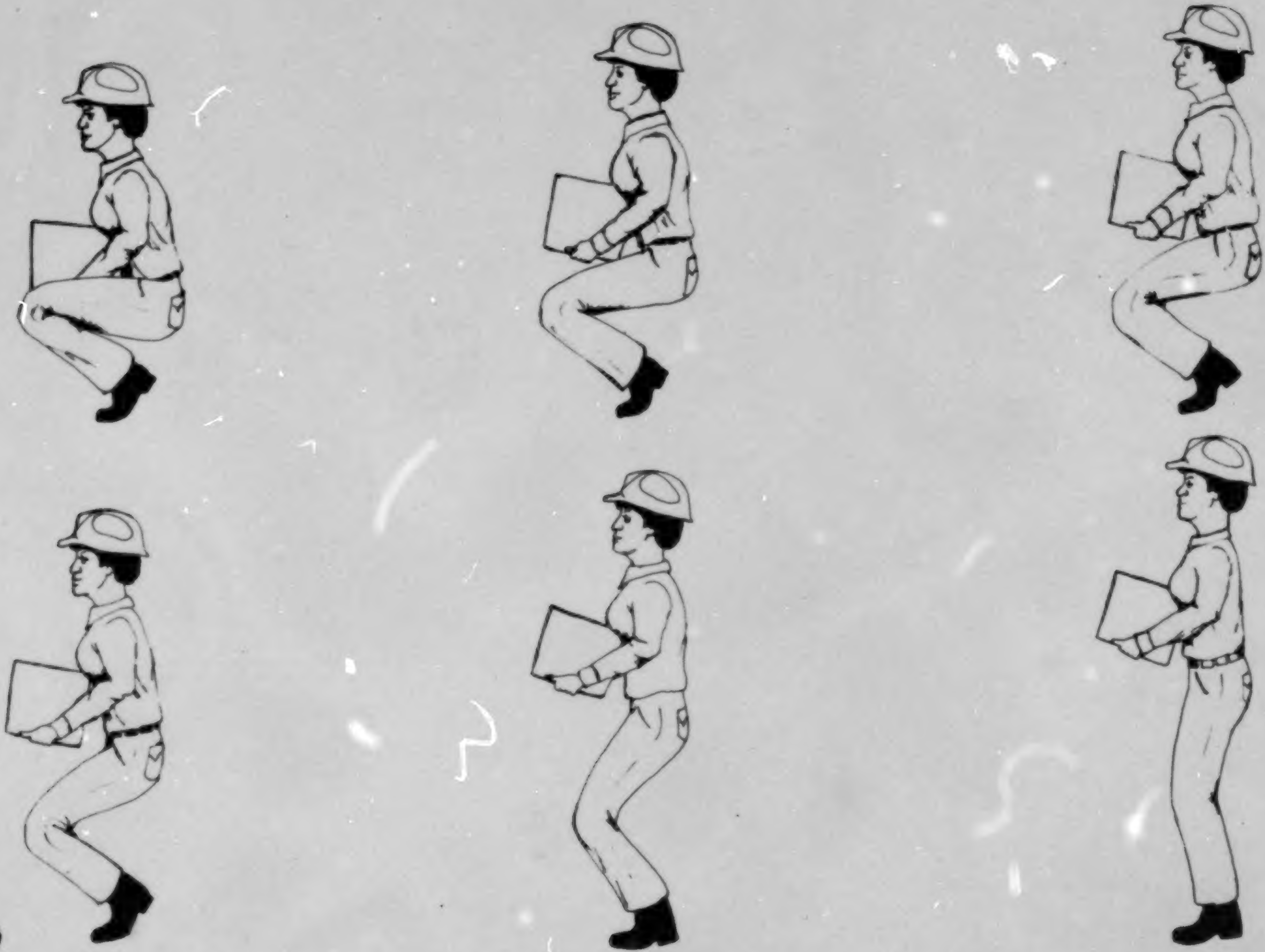
Correct Way to Lift Heavy Objects



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SAFETY AND FIRST AID
UNIT IV

ASSIGNMENT SHEET #1--COMPLETE A SAFETY PLEDGE FORM

NAME ______________________________ SCORE ______________

It is understood that each student and/or employee will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it. The student must assume responsibility for following safe practices. We, therefore, ask that the student subscribe to the following safety pledge.

1. I will follow all safety rules.
2. I will never use a machine without first having permission from the instructor.
3. I will not ask permission to use a particular machine unless I have been instructed in its use and have scored 100% on the safety test for that machine.
4. I will report any accident or injury, no matter how minor, to my instructor or supervisor immediately.

Date __________ Student's and/or employee's signature ______________

Date __________ Foreman's signature ______________________

Date __________ Supervisor's signature ______________________

Parental consent is necessary if the student/employee is under 18.

Date __________ Parent's signature ______________________

SAFETY AND FIRST AID
UNIT IV

ASSIGNMENT SHEET #2--ANALYZE ACCIDENT CASE STUDIES

NAME ____ SCORE ________________

SAFETY IS A PERSONAL RESPONSIBILITY. Without a doubt most accidents result from taking careless risks. Not only can accidents cause physical harm and loss of work time, but unsafe situations and actions affect your co-workers and company.

Study each of the case studies that follow. Think through them carefully. What caused the accidents? Could they have been avoided? What "costs" were involved besides financial ones?

ASSIGNMENT SHEET #2

CASE STUDY #1

Victim: Arlando Rodriquez, age 24, 19 months' experience

Job description: Using a bulldozer winch to move telephone poles

Accident description: Arlando Rodriquez was using his bulldozer winch to skid telephone poles. A pole lodged against a boulder. Arlando shut down the machine and set the parking brake before dismounting to determine the problem. As he approached the boulder, the taut winch cable snapped, catching him in the ribs and flinging him to the ground.

1. Assuming that you have witnessed the accident and are nearby to help, what would you do first? ____________________

____

____

2. What immediate first aid measures would you take? ____________________

____

____

3. What safety precautions did the worker observe? ____________________

____

____

4. What safety precautions did the worker fail to observe? ____________________

____

____

5. What factors may have caused the accident? ____________________

____

____

6. Could this accident have been avoided? __________ How? __________

____

____

7. What do you think will be some of the consequences or results of this accident?

____

____

____

ASSIGNMENT SHEET #2

CASE STUDY #2

Victim: Jane Perkins, age 29, 7 years' experience

Job description: Using hydraulic crane to lift building materials to second floor work area

Accident description: While lifting an I-beam, Jane allowed the hydraulic crane boom to come too close to an electrical power line. Jane remained in the cab and did not touch the machine's metal structure until the boom was cleared of the wire. However, in her haste to be free of the situation, she left the cab without cutting off the power or properly locking the controls. As she dismounted, the crane moved forward, severely gashing her shin.

1. Assuming that you have witnessed the accident and are nearby to help, what would you do first? ________________________________
2. What immediate first aid measures would you take? ________________________________
3. What safety precautions did the worker observe? ________________________________
4. What safety precautions did the worker fail to observe? ________________________________
5. What factors may have caused the accident? ________________________________
6. Could this accident have been avoided? ____________ How? ____________
7. What do you think will be some of the consequences or results of this accident? ________________________________

ASSIGNMENT SHEET #2

CASE STUDY #3

Victim: Adam Stilloaks, age 40, 14 years' experience

Job description: Removing a 300 lb. cable drum from an elevator and installing a new one

Accident description: Because of his 14 years' experience, Adam was assigned a young trainee, Shirley Jackson. Proud that he has been chosen by his supervisor to instruct the attractive trainee, Adam demonstrated the proper way to lift heavy objects. But, he attempted to lift the old cable drum himself. He heard and felt his back pop, and found that he could not straighten up without severe pain.

1. Assuming that you have witnessed the accident and are nearby to help, what would you do first? ______________________________
2. What immediate first aid measures would you take? ______________________________
3. What safety precautions did the worker observe? ______________________________
4. What safety precautions did the worker fail to observe? ______________________________
5. What factors may have caused the accident? ______________________________
6. Could this accident have been avoided? __________ How? ______________________________
7. What do you think will be some of the consequences or results of this accident? ______________________________

ASSIGNMENT SHEET #2

CASE STUDY #4

Victim: Joel McCreedy, age 22, 5 months' experience

Job description: Using a crawler to dump fill into a truck

Accident description: Joel was leveling a rough work area, preparatory to beginning the job. His crawler motor stopped, and he could not start it with cranking. Joel jumped from the machine to check the battery. He laid his metal rule accross the battery posts to determine the charge. Because the air directly over the battery was filled with hydrogen gas, the heavy sparks caused the battery to explode. Joel was thrown to the ground with acid burns to his hands, face, and eyes.

1. Assuming that you have witnessed the accident and are nearby to help, what would you do first? ______________________________
____
____

2. What immediate first aid measures would you take? ____________________
____
____

3. What safety precautions did the worker observe? ____________________
____
____

4. What safety precautions did the worker fail to observe? ________________
____
____

5. What factors may have caused the accident? ____________________
____
____

6. Could this accident have been avoided? __________ How? __________
____
____

7. What do you think will be some of the consequences or results of this accident?
____
____
____

ASSIGNMENT SHEET #2

CASE STUDY #5

Victim: Simber Lee Quentin, age 36, 15 years' experience

Job description: Moving a compressor with an oil leak from the shop to a nearby storage shed

Accident description: Simber Lee had just returned from a noon dental appointment when her supervisor asked her to move a compressor with an oil leak from the shop to a nearby storage shed. It was raining, but Simber Lee went outside to get a dolly to move the compressor. On returning, she stepped up to the machine, slipped on the oily floor, and fell. Her head struck the concrete floor, and she was knocked unconscious.

1. Assuming that you have witnessed the accident and are nearby to help, what would you do first? ______

2. What immediate first aid measures would you take? ______

3. What safety precautions did the worker observe? ______

4. What safety precautions did the worker fail to observe? ______

5. What factors may have caused the accident? ______

6. Could this accident have been avoided? ______ How? ______

7. What do you think will be some of the consequences or results of this accident? ______

ASSIGNMENT SHEET #2

CASE STUDY #6

Victim: Elsworth Barnes, age 20, 4 months' experience

Job description: Driving a loader from one job site to another

Accident description: Proud to be given the responsibility of tramming the company's loader on a public highway from one work site to another five miles away, Elsworth tipped his hard hat at passing motorists and recklessly increased his speed. His loader suddenly "duckwalked" off the road and went down an eight foot embankment. The loader rolled over crushing Elsworth, who died instantly.

1. Assuming that you have witnessed the accident and are nearby to help, what would you do first?
2. What immediate first aid measures would you take?
3. What safety precautions did the worker observe?
4. What safety precautions did the worker fail to observe?
5. What factors may have caused the accident?
6. Could this accident have been avoided? How?
7. What do you think will be some of the consequences or results of this accident?

SAFETY AND FIRST AID
UNIT IV

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1–Evaluated to satisfaction of instructor

Assignment Sheet #2

Case Study #1

Student responses will vary, but answers should include:

1. Remove cable if it has fallen on victim.
2. Observe overall emergency. (Arlando probably suffered fractured ribs, and may have punctured a lung.)

   Do not move victim.

   Check breathing; if victim is not breathing, begin mouth-to-mouth resuscitation.

   Observe pupil reactions of eyes.

   If victim is conscious, check alertness level, and ask about physical status.

   Treat for shock if necessary.

   Use the site's emergency phone and phone numbers to report the accident and to call for professional medical help.
3. Arlando was using the proper piece of equipment for the job at hand; he shut down the machine and set the parking brake before dismounting from the bulldozer.
4. Arlando stood near a cable under tension; he should have relieved the winch cable tension before dismounting.
5. Arlando did not observe safety rules or use good judgment in the use of a bulldozer winch.
6. Yes. Arlando could have avoided the accident by having a thorough knowledge of the machine in question and by following safety rules pertaining to using a bulldozer winch.
7. Accident results include damage to equipment, personal injury, time lost from work, and perhaps some delay in the work schedule.

Case Study #2

Student responses will vary, but answers should include:

1. Shut down crane, or call someone else to shut down crane while you attend to victim.

ANSWERS TO ASSIGNMENT SHEETS

2. Observe overall emergency.

   Control bleeding by direct pressure. (Apply pressure to femoral artery and elevate leg if bleeding is profuse.)

   Treat victim for shock if necessary.

   Use the site's emergency phone and telephone numbers to report the accident and to call for professional medical help.

3. Jane remained in the crane and did not touch the cab's metal structure until the boom was cleared from the wire.

4. Jane failed to observe the recommended safe distance of separation between crane boom and high power lines. (After seven years' experience, she should have known that it is not necessary to actually come in contact with a high power line for the electrical energy to ground through the machine.) She dismounted without shutting down the machine or lowering and locking the boom.

5. Jane did not observe safety precautions for working near utility lines. Also, she used poor judgment (panicked) when dismounting the crane, and thus failed to properly shut down the machine.

6. Yes. Jane could have avoided the accident by observing the safety rules pertaining to working with a crane around high power wires and dismounting a machine.

7. Accident results include damage to equipment, perhaps some property damage, personal injury, time lost from work, and perhaps some delay in work schedule.

Case Study #3

Student responses will vary, but answers should include:

1. Send Shirley Jackson to use the site's emergency phone and telephone numbers to report the accident and to call for professional medical help.

2. Observe overall accident. (Adam definitely has a back injury and may have ruptured a spinal disc.)

   Do not try to straighten victim up.

   Check alertness and ask about physical status.

   If victim feels faint or has fallen to floor, try to slip a board or other hard surface under him.

   Treat for shock if necessary.

3. Adam assumed the proper position for lifting heavy objects.

4. Adam tried to lift a very heavy object by himself.

5. The accident was caused by Adam's sense of pride and his carelessness regarding safe lifting measures.

ANSWERS TO ASSIGNMENT SHEETS

6. Yes. The victim should have asked for assistance in removing the old cable drum.

7. Accident results include personal injury and loss of work time.

Case Study #4

Student responses will vary, but answers should include:

1. Try to calm victim and keep him from touching his face.

2. Observe overall accident. (Joel probably suffers from second and third degree acid burns.)

   Treat for acid burns: If possible, find some water to flush face, hands, and particularly eyes; cover eyes with dry dressing or clean material if available.

   Treat for shock.

   Use the site's emergency phone and telephone numbers to report the accident and to call for professional medical help.

   Try to keep the victim as comfortable and as still as possible while awaiting help.

3. Joel was smoothing (leveling) a rough work area before beginning his job.

4. Joel jumped from his machine rather than using the steps and grab irons; he checked the battery charge by placing a metal object across the posts rather than by using a proper tool--a voltmeter or hydrometer.

5. The accident may have been caused by Joel's inexperience. His carelessness and his failure to follow recommended safety precautions when testing a battery were certainly contributing causes.

6. Yes. Joel could have avoided the accident by having a thorough knowledge of the machine in question, and by observing safety rules pertaining to checking a battery charge.

7. Accident results include permanent personal injury, damage to equipment, time lost from work (perhaps permanent).

Case Study #5

Student responses will vary, but answers should include:

1. Observe overall emergency. (Simber Lee may have suffered a concussion or head wound.)

2. Check breathing; if victim is not breathing begin mouth-to-mouth resuscitation.

   Observe pupil reactions of eyes.

   Feel back of head for open wound.

ANSWERS TO ASSIGNMENT SHEETS

If victim is conscious, check alertness level, and ask about physical status.

Treat for shock if necessary.

Use the site's emergency phone and telephone numbers to report the accident and to call for professional medical help.

3. Simber Lee planned to use a dolly to move a heavy object.
4. Simber Lee neglected to wipe up a spill in the work area.
5. The combination of wet shoes and oil on the floor probably caused the accident.
6. Yes. Simber Lee could have avoided the accident by wiping up the spilled oil on the work area floor.
7. Accident results include personal injury and time lost from work.

Case Study #6

Student responses will vary, but answers should include:

1. Turn off machine if possible.
2. Observe overall emergency. (Call to victim to see if he answers; extract victim from wreckage if possible.)

   Check breathing; if victim is not breathing, begin mouth-to-mouth resuscitation.

   Check pulse or heartbeat; if victim shows no heartbeat, you may want to try CPR (cardio-pulmonary resuscitation), BUT ONLY IF YOU HAVE BEEN TRAINED IN THIS TECHNIQUE.

   If you raise no vital signs after an extended period of time, telephone for professional medical help, or flag someone down and send them for help.
3. Elsworth wore his hard hat.
4. Elsworth failed to drive at the low speed recommended for safe tramming. Elsworth's supervisor, however, bears most of the responsibility for this accident. The operator was too inexperienced to be tramming a loader. Further, five miles is too great a distance to tram a loader. The machine should have been transported to the work site on a trailer. Large, heavy machines are not designed for open road extended travel.
5. The accident was caused by carelessness on the part of Elsworth's supervisor and by Elsworth's recklessness.
6. Yes. Elsworth should have driven the machine more slowly. The supervisor should have chosen someone more experienced for the job, should have trained his workers to the dangers of the equipment, and should not have allowed the machine to be trammed to the other work site.
7. Accident results include death, destruction of equipment and property, loss of a worker, and delay in work schedule.

SAFETY AND FIRST AID
UNIT IV

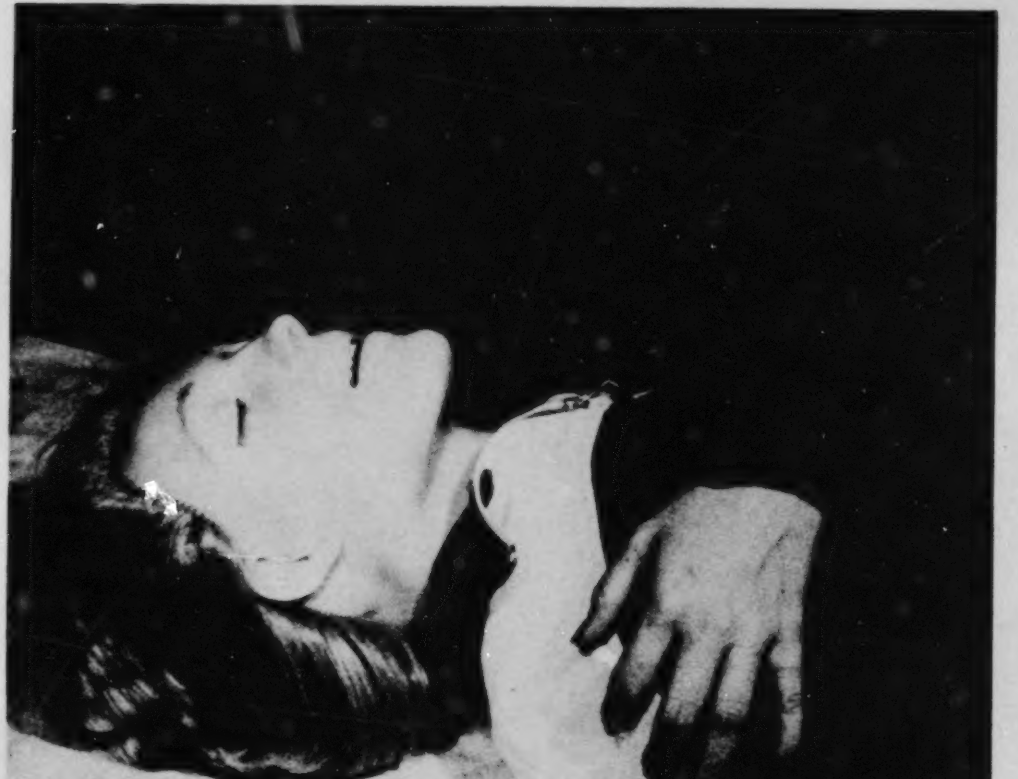
JOB SHEET #1--GIVE MOUTH-TO-MOUTH RESUSCITATION

I. Clear victim's air passage

A. Place victim flat on back (Figure 1)

(NOTE: If it is necessary to roll victim over, try to roll the victim over all at once, keeping back and neck straight to avoid making any possible spinal injury worse.)

FIGURE 1

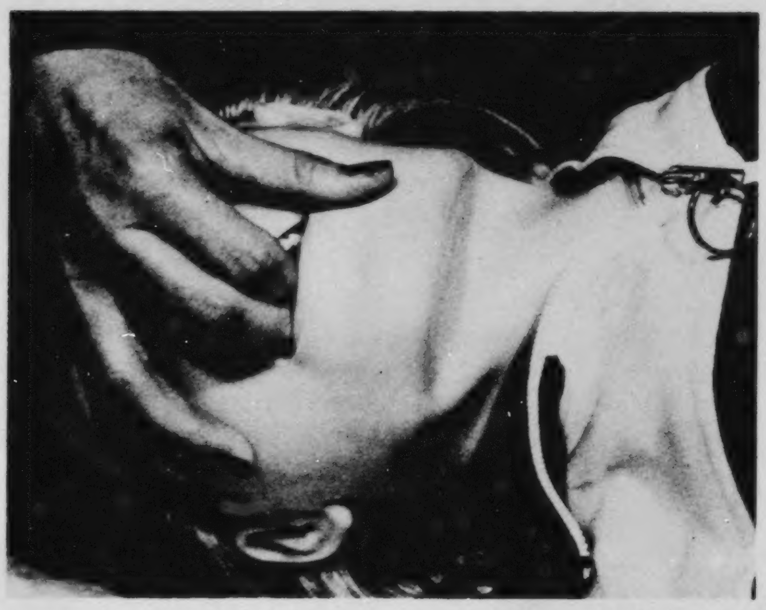


JOB SHEET #1

B. Remove all foreign objects from victim's mouth and throat (Figure 2)

(NOTE: If there is an obstruction, carefully turn victim on side, tilt head down, and clean mouth out with your fingers. When obstruction is removed, carefully position victim onto back again.)

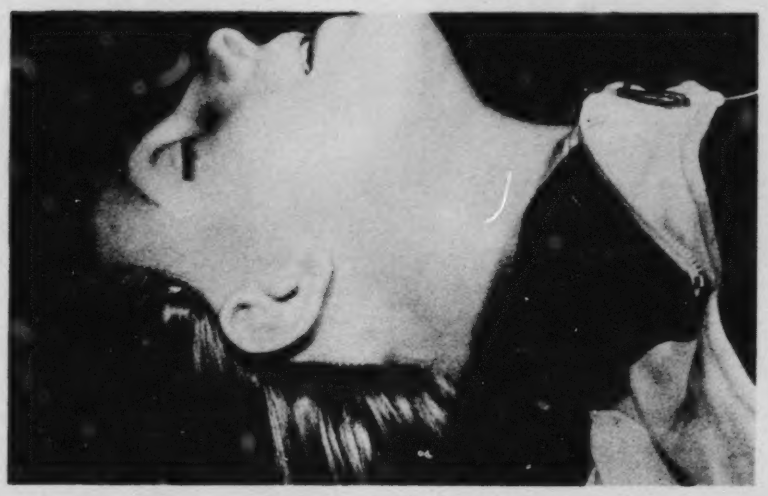
FIGURE 2



C. Kneel at the victim's side and lift up under the neck, tilting crown of head backwards (Figure 3)

(NOTE: If possible, place a rolled piece of clothing under the victim's shoulders; this will help to secure the backward tilt of head.)

FIGURE 3

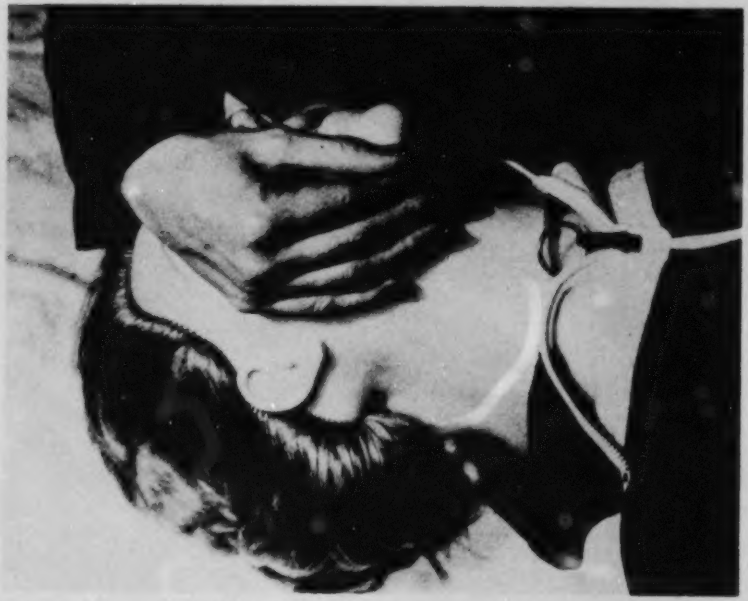


JOB SHEET #1

D. Pull the lower jaw so the chin points straight up (Figure 4)

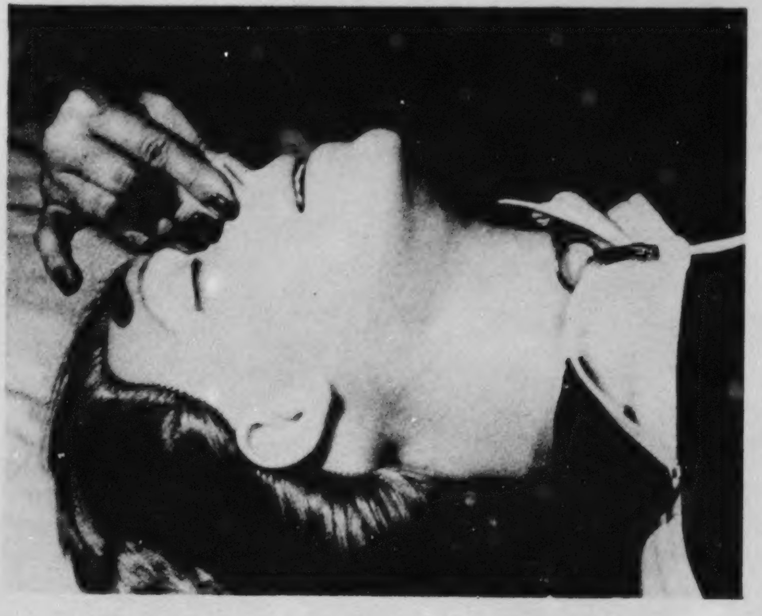
(NOTE: This will pull the tongue forward and open the air passage.)

FIGURE 4



E. Pinch the nostrils shut while still lifting up under the victim's neck (Figure 5)

FIGURE 5

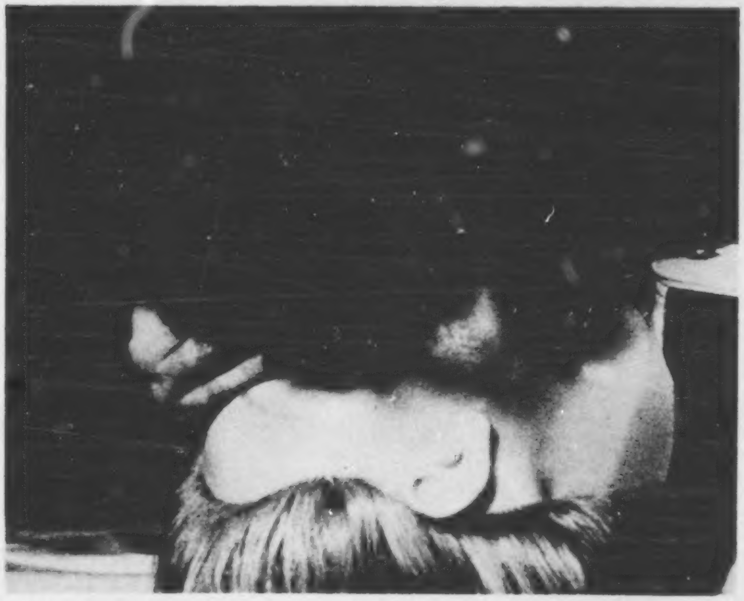


JOB SHEET #1

F. Inhale deeply, and while making an airtight seal with your mouth over the victim's mouth, breathe into victim's mouth until chest rises (Figure 6)

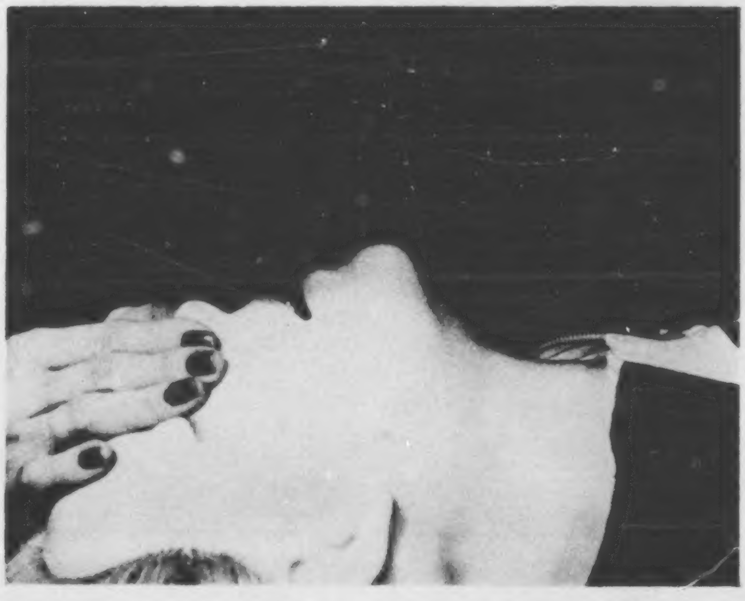
(CAUTION: Keep the victim's chin extended at all times.)

FIGURE 6



G. Remove your mouth from victim's mouth and listen for return flow of air (Figure 7)

FIGURE 7



SAFETY AND FIRST AID
UNIT IV

JOB SHEET #2--SHOW PROPER WAY TO LIFT

(NOTE: It is understood that each student will be given proper instructions on lifting before attempting to lift a heavy object. It is also advised that students view the film *A New Way to Lift.*)

I. Material and equipment

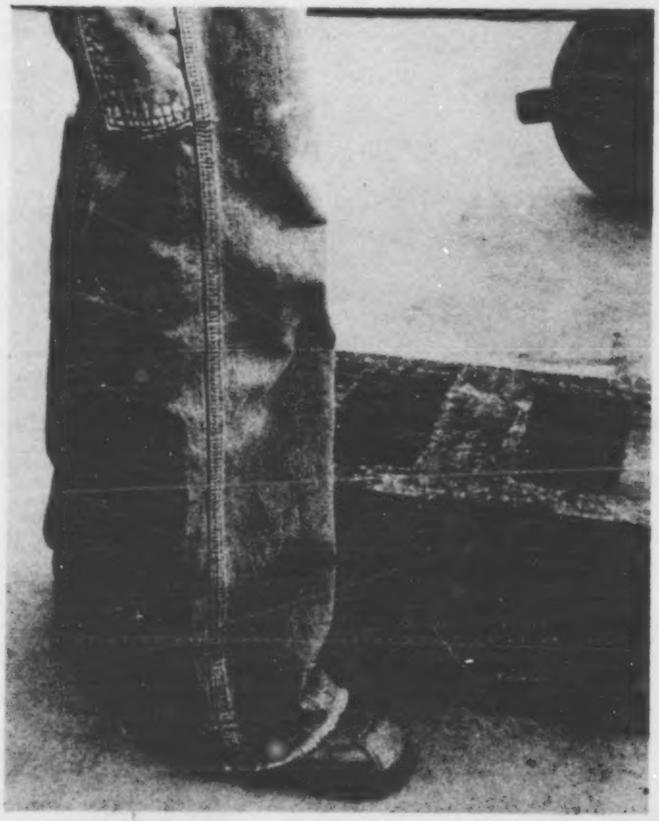
  A. A person

  B. Heavy object

II. Procedure

  A. Step up to object with feet apart; place one foot beside object and one behind (Figure 1)

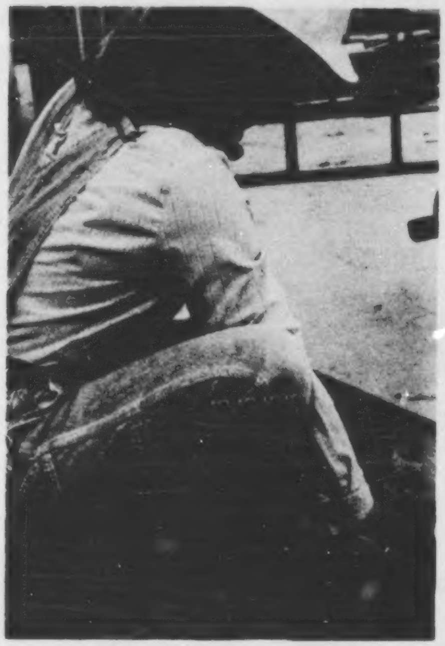
FIGURE 1



JOB SHEET #2

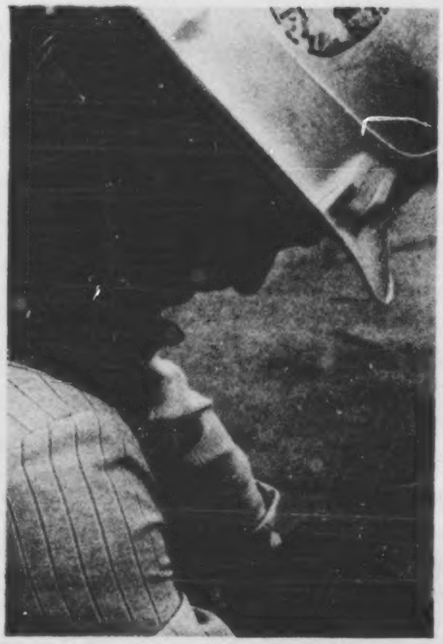
B. Keep back straight (Figure 2)

FIGURE 2



C. Tuck chin in (Figure 3)

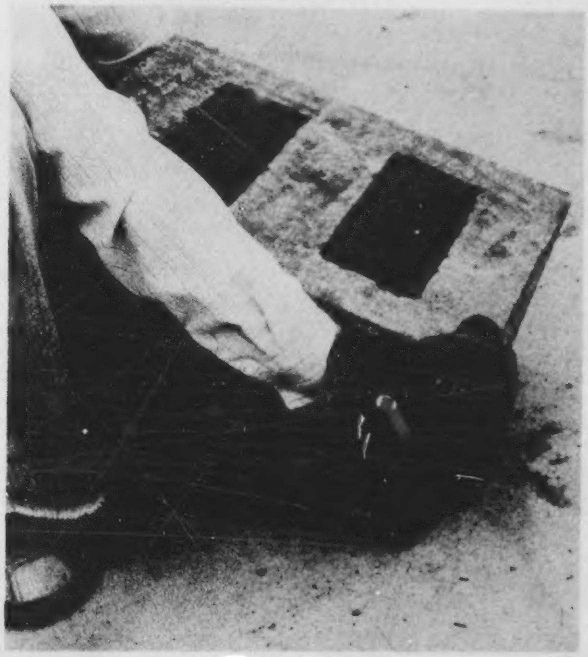
FIGURE 3



JOB SHEET #2

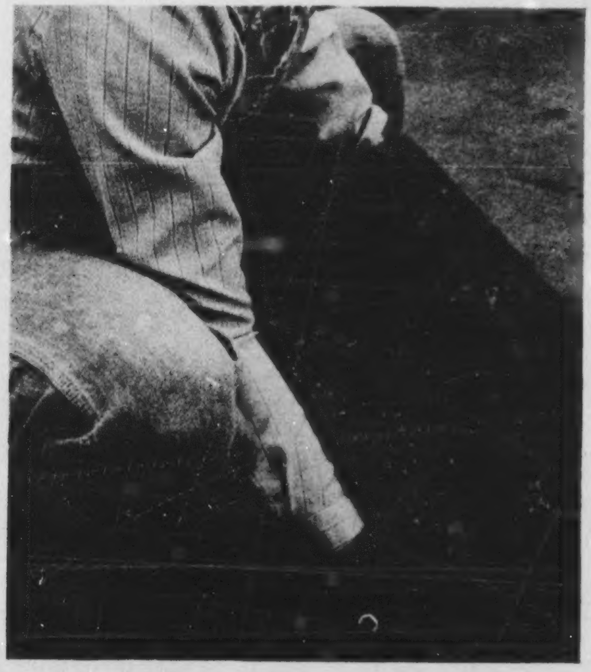
D. Grasp object with whole hand (Figure 4)

FIGURE 4



E. Tuck in elbows and arms and hold load close to body (Figure 5)

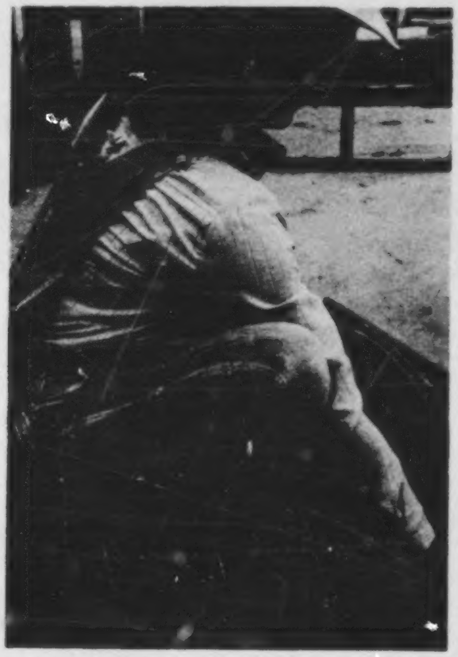
FIGURE 5



JOB SHEET #2

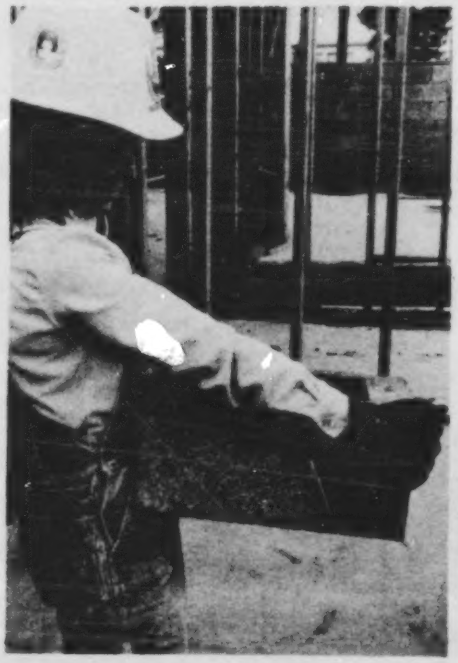
F. Keep body weight directly over feet (Figure 6)

FIGURE 6



G. Lift object (Figure 7)

FIGURE 7



SAFETY AND FIRST AID
UNIT IV

TEST

NAME ______________________________ SCORE ____________________

1. Match terms associated with safety and first aid to the correct definitions. Write the correct numbers in the blanks provided.

______a. State or condition of being safe; freedom from danger, risk, or injury

______b. Any suddenly occurring, unintentional event which causes injury or property damage

______c. Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

______d. Federal legislation designed to ensure safe and sanitary working conditions for employees

______e. Capable of being easily ignited and burning with extreme rapidity

______f. Something tending to explode

______g. Capable of bursting into flames

______h. Combined processes of emission, transmission, and absorption of radiant energy

______i. To cause to cease burning

______j. Container in which a liquid is stored under pressure greater than the pressure of the atmosphere

______k. Liquid substance capable of dissolving or dispersing one or more other substances

______l. Air-powered

______m. Source of danger

______n. Tilted; at an angle

1. Sloping
2. Pressurized
3. Flammable
4. Tramming
5. Safety
6. Extinguish
7. Solvent
8. Hazard
9. Occupational Safety and Health Act (OSHA)
10. Accident
11. Combustible
12. Resuscitation
13. Radiation
14. Pneumatic
15. Explosive
16. First aid
17. MSHA

______o. Moving of any self-propelled equipment

______p. Act of bringing one back to full consciousness

______q. Mine Safety and Health Administration

2. State five reasons for practicing job safety.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

3. Match the colors of the safety color code to the correct applications. Write the correct numbers in the blanks provided. (An answer may be used more than once.)

______a. Designates caution and marks physical hazards

______b. Identifies fire protection equipment and its location

______c. Designates location of safety and first-aid equipment

______d. Designates dangerous parts of equipment which may cut, crush, shock, or otherwise injure

______e. Designates caution against starting, using, or moving equipment while under repair, or against the use of defective equipment

______f. Designates traffic flow

______g. Designates radiation hazards

______h. Designates danger

1. Federal safety green
2. Federal safety white
3. Federal safety orange
4. Federal safety purple
5. Federal safety black
6. Federal safety red
7. Federal safety yellow

4. State five personal safety rules.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

5. State ten rules for general job safety.

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________

    f. ______________________________

    g. ______________________________

    h. ______________________________

    i. ______________________________

    j. ______________________________

6. Select from the following list the components of the fire triangle. Mark each correct answer with an "X."

    ______a. Fire

    ______b. Oxygen

    ______c. Carbon dioxide (CO_2)

    ______d. Fuel

    ______e. Heat

    ______f. Water

7. Match classes of fires to the correct descriptions. Write the correct numbers in the blanks provided.

    ______a. Fires that occur with flammable liquids, such as gasoline, oil, grease, paint, and thinners

    ______b. Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish

    ______c. Fires that occur in or near electrical equipment, such as motors, switchboards, and electrical wiring

    ______d. Fires that occur with combustible metals, such as iron or magnesium

    1. Class A
    2. Class B
    3. Class C
    4. Class D

8. Match types of fire extinguishers to the classes of fire for which each is used. Write the correct numbers in the blanks provided. (A blank may have more than one correct number.)

_____ a. Used on Class A fires *only*

_____ b. Used on Class A fires

_____ c. Used on Class B and C fires

_____ d. Used on Class B, C, and D fires

_____ e. Used on Class A and B fires

1. Pressurized water
2. Carbon dioxide
3. Dry chemical
4. Soda acid
5. Foam
6. Multipurpose dry chemical
7. Water pump tank

9. Describe five procedures used to maintain a clean and orderly work area.

a. ____

____

b. ____

____

c. ____

____

d. ____

____

e. ____

____

10. Describe procedures used to lift heavy objects correctly.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

h. ____

11. State three safety rules concerning flammable liquids.

a. ____________________

b. ____________________

c. ____________________

12. Name reasons why knowledge of first aid is important.

a. ____________________

b. ____________________

c. ____________________

13. Discuss reasons why first aid skills are needed.

____

____

____

____

14. Arrange in order immediate steps to follow when giving first aid to an accident victim. Place a "1" for the first step, a "2" for the second step, and so on in the blanks provided.

_____a. Observe pupil reactions of the eyes

_____b. Check breathing

_____c. Begin definite first aid treatment for symptoms

_____d. Observe overall emergency

_____e. If victim is conscious, check alertness level by asking questions about physical status

_____f. Check pulse or heartbeat

15. Select from the list below factors to consider in first aid treatment of shock. Place an "X" in the correct blanks.

_____a. Get medical help as soon as possible

_____b. Help victim sit up immediately

_____c. Cover victim to prevent loss of body heat and to stabilize blood circulation

_____d. Give victim fluids immediately

_____e. Maintain adequate supply of oxygen

16. Classify burns by degree according to their descriptions. Place a "1" for first degree burns, a "2" for second degree burns, and a "3" for third degree burns in the blanks provided.

______a. Blistering

______b. Rapid healing

______c. Mottled or red areas

______d. Charred or a white-casted appearance

______e. Damage extending into the first layer of tissue

______f. Redness or discoloration

______g. Mild swelling and pain

______h. Pain greater than first degree

______i. Considerable swelling

______j. Deep tissue destruction

______k. Wet appearance of burned area due to loss of plasma

______l. Less pain due to nerve destruction

17. Match first, second, and third degree burns with their correct first aid treatments.

______a. Submerge the part in cold but not ice water until pain eases; blot dry gently and apply dry, sterile dressings; do not break blisters, and do not use any ointments, sprays, or home remedies on burned area

______b. Apply cold water or submerge burned area in cold water; apply a dry dressing if necessary

______c. Cover burns with thick sterile dressings, but do not immerse in water; do not remove any tissue or burned clothing; transport victim to hospital as quickly as possible

1. Third degree
2. First degree
3. Second degree

18. Describe steps to follow to control bleeding by direct pressure.

____

____

____

____

____

19. Arrange in order steps to follow for mouth-to-mouth resuscitation. Write a "1" before the first step, a "2" before the second step, and so on in the blanks provided.

_____a. Inhale deeply; breathe into victim's mouth

_____b. Pinch nostrils together

_____c. Clear the air passage

_____d. Remove mouth from victim's mouth; listen for return flow of air

_____e. Extend chin by lifting up under neck

20. Complete a safety pledge form.

21. Analyze accident case studies.

22. Demonstrate the ability to:

    a. Perform mouth-to-mouth resuscitation.

    b. Show proper way to lift.

    (NOTE: If activities 20, 21, and 22 have not been finished before the test, ask your instructor when they should be completed.)

SAFETY AND FIRST AID
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 10
   c. 16
   d. 9
   e. 3
   f. 15
   g. 11
   h. 13
   i. 6
   j. 2
   k. 7
   l. 14
   m. 8
   n. 1
   o. 4
   p. 12
   q. 17

2. Any five of the following:
   a. Prevent physical harm to yourself and others
   b. Avoid loss of work
   c. Avoid possible loss of pay
   d. Lower cost to employer
   e. Prevent loss or damage of equipment or materials
   f. Lower insurance rates
   g. Prevent hardship on family
   h. Provide regular job schedules
   i. Prevent possible loss of job

3. a. 7
   b. 6
   c. 1
   d. 3
   e. 7
   f. 2, 5
   g. 4
   h. 6

4. Any five of the following:
    a. Wear clothing that is appropriate for the activity being performed
    b. Confine long hair before operating equipment
    c. Wear safety glasses, suitable hard hats, goggles, and respiratory equipment, where required
    d. Remove ties and loose sleeves when working around machine tools or rotating equipment
    e. Remove rings and other jewelry when working
    f. Be alert and conduct yourself in a manner to ensure safe practices
    g. Use soap and water frequently as a method of preventing skin disease
    h. Do not jump onto or off of moving equipment
    i. Be familiar with location of first-aid equipment
5. Any ten of the following:
    a. Keep all tools sharp, clean, and in safe working order
    b. Retain guards and safety devices on all equipment
    c. Report defective tools, machines, or other equipment to the supervisor
    d. Report all accidents to the supervisor, regardless of nature or severity
    e. Be sure machine and equipment operators turn off power and do not leave until equipment has stopped
    f. Disconnect power lock and tag out machine tools before performing maintenance
    g. Use correct, properly fitting wrenches on nuts and bolts
    h. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it
    i. Clean up any spilled liquids immediately
    j. Keep work area clear of scraps and litter
    k. Store oily rags and waste in proper containers
    l. Do not use compressed air to clean yourself or your clothing
    m. Be conscious of others' safety
    n. Be sure others are at a safe distance when operating moving equipment
    o. Use barricades and flaggers where required
    p. Maintain all safety rules and limitations on heavy equipment according to specifications and manufacturer's regulations

6. b, d, e

7. a. 2
   b. 1
   c. 3
   d. 4

8. a. 1, 7
   b. 1, 4, 5, 6, 7
   c. 2, 3, 6
   d. 3
   e. 5, 6

9. Description should include any five of the following:
   a. Arrange machinery and equipment to permit safe, efficient work practices and ease in cleaning
   b. Stock materials and supplies in the proper places
   c. Store tools and accessories in cabinets, on racks, or other suitable devices
   d. Clear work areas of debris and other hazards
   e. Clean slippery substances from floor
   f. Dispose of combustible materials properly
   g. Keep brooms, brushes, and other housekeeping equipment where it is readily available

10. Description should include:
    a. Step up to object with feet apart; place one foot beside object and one behind
    b. Lift with legs and not with the back
    c. Keep back straight, nearly vertical
    d. Tuck chin in
    e. Grasp object with whole hand
    f. Tuck elbows and arms in
    g. Hold load close to body
    h. Keep body weight directly over feet

11. Any three of the following:
    a. Know the location and use of fire extinguishers for flammable liquids
    b. Store all flammable liquids in approved safety containers
    c. Use only approved cleaning solvents to clean parts
    d. Do not operate an engine that is leaking gasoline
    e. Change oil or gasoline-soaked clothing immediately
    f. Do not fuel a running gasoline engine

12. a. May mean the difference between life and death
    b. May mean the difference between temporary and permanent injuries
    c. Trains one in what to do and what not to do in an emergency

13. Discussion should include:
    a. Accidents are the number one cause of death
    b. There may not be time to wait for professional medical help after an accident
    c. Safety awareness needs to be promoted at work

14. a. 4
    b. 2
    c. 6
    d. 1
    e. 5
    f. 3

15. a, c, e

16. a. 2
    b. 1
    c. 2
    d. 3
    e. 2
    f. 1
    g. 1
    h. 2
    i. 2
    j. 3
    k. 2
    l. 3

17. a. 3
    b. 2
    c. 1

18. Description should include:

    a. Apply dressing (prepared gauze, clean handkerchief, clean articles of clothing) to area using firm pressure with hand

    b. Check frequently to see if bleeding has stopped or slowed

    c. If bleeding is still active, apply a pressure bandage by holding dressing in place with one hand, wrapping bandage directly over and around the injured area, and tying the knot over the wounded area

    d. Elevate the limb, if possible, above the level of the victim's heart

    e. If bleeding continues, apply pressure on the main artery that supplies blood to the injured area

19. a. 4

    b. 3

    c. 1

    d. 5

    e. 2

20. Evaluated to the satisfaction of the instructor

21. Evaluated to the satisfaction of the instructor

22. Performance skills evaluated to the satisfaction of the instructor

BASIC MATH
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to solve basic math problems. This knowledge will be evidenced by completion of assignment sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with basic math to the correct definitions.
2. Match symbols used in math problems to the correct descriptions.
3. Solve addition problems.
4. Solve subtraction problems.
5. Solve multiplication problems.
6. Solve division problems.
7. Distinguish among types of fractions.
8. Convert mixed numbers to improper fractions.
9. Reduce fractions to lowest terms.
10. Add fractions.
11. Subtract fractions.
12. Write the place value of decimals.
13. Convert fractions to decimals.
14. Add decimals.
15. Subtract decimals.
16. Multiply decimals.
17. Divide decimals by decimals.
18. Divide whole numbers by decimals.
19. Convert fractions to decimals and percentages.
20. Convert percentages to fractions and decimals.

21. Solve percentage problems.

22. Complete a chart on decimal and fractional equivalents.

BASIC MATH
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

A. Provide student with objective sheet.

B. Provide student with information and assignment sheets.

C. Discuss unit and specific objectives.

D. Discuss information and assignment sheets.

E. Provide students with chart on decimal equivalents so that they may complete objective 20.

F. Give test.

(NOTE: It is recommended that this test be given in parts, such as the math processes, fractions, and decimals.)

II. Instructional materials:

A. Objective sheet

B. Information sheet

C. Assignment sheets

1. Assignment Sheet #1--Solve One-Digit Addition Problems
2. Assignment Sheet #2--Solve Two-Digit Addition Problems
3. Assignment Sheet #3--Solve Three-Digit Addition Problems
4. Assignment Sheet #4--Solve One-Digit Subtraction Problems
5. Assignment Sheet #5--Solve Two-, Three-, and Four-Digit Subtraction Problems
6. Assignment Sheet #6--Solve One-Digit Multiplication Problems
7. Assignment Sheet #7--Solve Multiplication Problems with One-Digit Multipliers
8. Assignment Sheet #8--Solve Multiplication Problems with Two- and Three-Digit Multipliers
9. Assignment Sheet #9--Solve Division Problems with One-Digit Divisors

10. Assignment Sheet #10--Solve Long-Division Problems
11. Assignment Sheet #11--Work with Fractions
12. Assignment Sheet #12--Convert Fractions
13. Assignment Sheet #13--Reduce Fractions to Lowest Terms
14. Assignment Sheet #14--Find Common Denominators
15. Assignment Sheet #15--Add Fractions
16. Assignment Sheet #16--Subtract Fractions
17. Assignment Sheet #17--Convert Fractions to Decimals
18. Assignment Sheet #18--Solve Addition Problems with Decimals
19. Assignment Sheet #19--Solve Subtraction Problems with Decimals
20. Assignment Sheet #20--Solve Multiplication Problems with Decimals
21. Assignment Sheet #21--Solve Division Problems with Decimals
22. Assignment Sheet #22--Write Fractions as Decimals and Percentages
23. Assignment Sheet #23--Write Percentages as Fractions and Decimals
24. Assignment Sheet #24--Solve Percentage Problems
25. Assignment Sheet #25--Find Percentages of Whole Numbers

D. Test

E. Answers to test

III. Unit references:

A. Hendrix, Laborn J., "Bud." *Millwright Instructional Materials.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

B. Morrison, Phyllis. *Basic Math Skills.* New York: McGraw-Hill Book Company, 1972.

C. Gossage, Loyce G., and Briggs, Milton. *Basic Mathematics Review.* Cincinnati, Ohio: South-Western Publishing Co., 1969.

BASIC MATH
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Digit--Any one of the ten symbols, 0 to 9, by which all numbers may be expressed

B. Subtraction--Opposite (inverse) operation of addition

C. Multiplication--An abbreviated process of adding an integer to itself a specified number of times

Example: 6 x 3 = 18 or 6 + 6 + 6 = 18

D. Integer--Any of the natural numbers; the whole numbers positive and negative

E. Division--Opposite (inverse) operation of multiplication

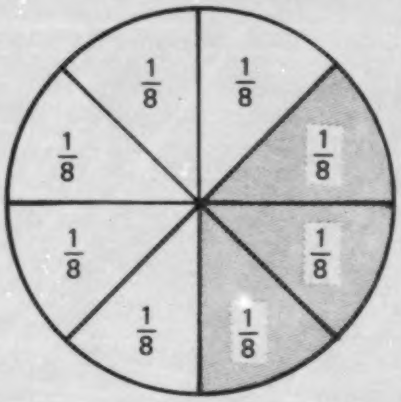
Example: 16 ÷ 2 = 8

F. Problem--Mathematical proposition

G. Calculate--To solve by mathematical process

H. Fraction--Part of a whole; represents one or more equal parts of a unit

Example: If the unit is divided into eight equal parts, then each part is one-eighth (1/8) of the unit; the fraction three-eighths (3/8) means three of the parts, as shown in the shaded portion of the figure below



I. Caret (∧)--Mark made to indicate where something is to be inserted

INFORMATION SHEET

J. Decimals--Fractions based on the number 10; not written as common fractions

Examples: $\frac{1}{10} = 0.1$

$\frac{6}{100} = 0.06$

$\frac{3}{1000} = 0.003$

K. Perimeter–Outer limits or boundary

L. Percent–One part in a hundred; reckoned on the basis of a whole divided into one hundred parts

M. Unit--First natural number

II. Symbols used in math problems

	Name of Symbol	Symbol(s)
A.	Addition	+
B.	Subtraction	—
C.	Division	÷ $\overline{)\quad\quad}$
D.	Multiplication	×
E.	Equal	=
F.	Decimal	.
G.	Percent	%
H.	Caret	∧

III. Addition (Assignment Sheets #1, #2, and #3)

A. Write units under units, tens under tens, and so on

B. Begin adding the far right column

C. If sum of any column is ten or more, write last figure and carry other figure

Example:

$$\begin{array}{r} 1420 \\ 15 \\ +\ 123 \\ \hline 1558 \end{array} \qquad \begin{array}{r} 1 \\ 1352 \\ 17 \\ +\ 260 \\ \hline 1629 \end{array}$$

carried figure

INFORMATION SHEET

IV. Subtraction (Assignment Sheets #4 and #5)

A. Write units under units, tens under tens, and so on

B. When subtracting, bottom figure almost always will be smaller than top figure

C. Begin with the first column on the far right, and move to the left

Example:

$$\begin{array}{r} 784 \\ -431 \\ \hline 353 \end{array}$$

V. Multiplication (Assignment Sheets #6, #7, and #8)

A. Write the larger factor above the smaller factor

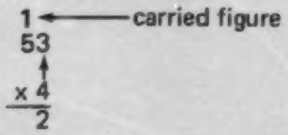
(NOTE: Write units under units, tens under tens, and so on.)

B. If multiplier has only one figure, multiply each number above by this figure, starting from right and working in order to the left

Example:

Multiply by one figure

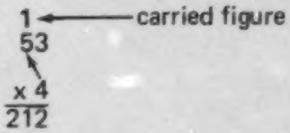
4 x 53 = 212


1
carried figure
53
x 4
2

C. Write the results and carry over the tens

D. Multiply the second figure and add the number carried

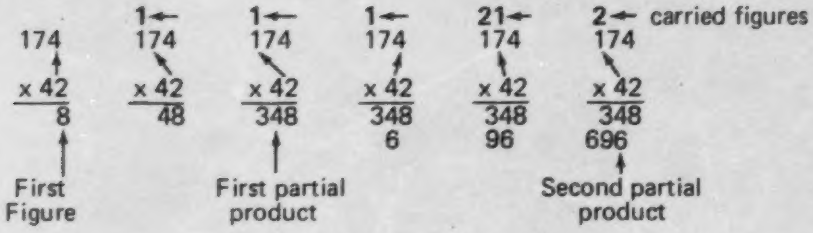
Example:


1
carried figure
53
x 4
212

E. If multiplier has more than one figure, find partial products by multiplying each number above by first figure and recording; then multiply by second figure and record products under each other, placing the numbers so that right-hand figure of each partial product is directly under its corresponding figure in the multiplier

Example: Multiply by two figures

42 x 174 = 7308


174
x 42
8
1
174
x 42
48
1
174
x 42
348
1
174
x 42
348
6
21
174
x 42
348
96
2
174
x 42
348
696
carried figures
First Figure
First partial product
Second partial product

INFORMATION SHEET

F. Add the partial products

Example:
$$\begin{array}{r} 174 \\ \underline{\times\,42} \\ 348 \\ \underline{696} \\ 7308 \end{array} = \text{Product}$$

VI. Division (Assignment Sheets #9 and #10)

A. Write inside the frame the number to be divided; write the number you are dividing by on the outside of frame

Example: $1974 \div 6$ $\qquad 6\,\overline{)1974}$

B. Determine how many times number on outside will go into the first number on the inside; if it will not, determine how many times it will go into first two numbers and write this figure on top of frame above the right digit of the number it went into

Example: $1974 \div 6$
$$\begin{array}{r} 3 \\ 6\,\overline{)1974} \end{array}$$

C. Multiply number on outside of frame by number on top; write results under the figures the outside number went into, and subtract these figures

Example: $1974 \div 6$
$$\begin{array}{r} 3 \\ 6\,\overline{)1974} \\ \underline{18} \\ 1 \end{array}$$

D. Bring down the next figure; determine how many times the number on outside of frame will go into bottom figure, and write it above the figure that was brought down

Example: $1974 \div 6$
$$\begin{array}{r} 32 \\ 6\,\overline{)1974} \\ \underline{18} \\ 17 \\ \underline{12} \\ 5 \end{array}$$

F. Bring down next figure; determine how many times number on outside of frame will go into it and write it above figure that was brought down; multiply times the number on outside and write the results

Example: $1974 \div 6$
$$\begin{array}{r} 329 \\ 6\,\overline{)1974} \\ \underline{18} \\ 17 \\ \underline{12} \\ 54 \\ \underline{54} \end{array}$$

INFORMATION SHEET

VII. Types of fractions (Assignment Sheet #11 and #12)

A. Proper--Top number of fraction (numerator) is smaller than the bottom number of fraction (denominator)

Example: $\frac{8}{9}$ (8 = numerator; 9 = denominator)

B. Improper--Top number of fraction (numerator) is larger than, or equal to, the bottom number of fraction (denominator)

Examples: $\frac{8}{6}$, $\frac{7}{7}$

C. Mixed--Contains a whole number and a fraction

Examples: $9\frac{1}{2}; 4\frac{2}{3}; 1\frac{7}{8}$

VIII. Converting mixed numbers to improper fractions (Assignment Sheet #12)

A. Multiply the denominator of the fraction by the whole number

B. Add the numerator of the fraction

(NOTE: This number becomes the numerator.)

Examples: $4\frac{3}{5} = \frac{(5 \times 4) + 3}{5} = \frac{23}{5}$

$7\frac{1}{2} = \frac{(2 \times 7) + 1}{2} = \frac{15}{2}$

IX. Reducing fractions to lowest terms--Divide the numerator and denominator by a whole number that will go into each of them evenly (Assignment Sheets #13 and #14)

Examples: 4/6 is not reduced to lowest terms because both the numerator (4) and the denominator (6) can be divided by 2

$$\frac{4}{6} = \frac{4}{6} \div \frac{2}{2} = \frac{2}{3}$$

2/3 is reduced because the numerator (2) and the denominator (3) cannot be divided by the same number

X. Adding fractions (Assignment Sheet #15)

A. Common fractions

1. Add the numerators
2. Place over common denominator

Example: $\frac{1}{4} + \frac{2}{4} = \frac{3}{4}$

INFORMATION SHEET

B. Uncommon fractions

1. Change the fractions to equivalent fractions (like fractions)
2. Add as like fractions

Example:

$$\begin{array}{rcr} \frac{1}{3} \times \frac{5}{5} & = & \frac{5}{15} \\ \frac{2}{5} \times \frac{3}{3} & = & + \frac{6}{15} \\ \hline & & \frac{11}{15} \end{array}$$

C. Mixed numbers

1. Add whole numbers
2. Add fractions
3. Combine these two answers

Examples:

$$\begin{aligned} 3\frac{1}{7} + 7\frac{2}{7} &= (3 + 7) + \left(\frac{1}{7} + \frac{2}{7}\right) \\ &= 10 + \frac{3}{7} \\ &= 10\frac{3}{7} \end{aligned}$$

$$\begin{aligned} 4\frac{2}{3} + 1\frac{5}{6} &= (4 + 1) + \left(\frac{2}{3} + \frac{5}{6}\right) \\ &= 5 + \left(\frac{4}{6} + \frac{5}{6}\right) \\ &= 5 + \frac{9}{6} \\ &= 5 + 1\frac{3}{6} \\ &= 5 + 1\frac{1}{2} \\ &= 6\frac{1}{2} \end{aligned}$$

INFORMATION SHEET

XI. Subtracting fractions (Assignment Sheet #16)

A. Common fractions

(NOTE: Common fractions are sometimes called *like fractions*; they share the same denominator.)

1. Subtract the numerators
2. Place over denominator
3. Reduce to lowest terms

Example:

$$\begin{array}{r} \frac{7}{11} \\ - \frac{1}{11} \\ \hline \frac{6}{11} \end{array}$$

B. Uncommon fractions

(NOTE: Uncommon fractions are sometimes called *unlike fractions*; they have unlike denominators.)

1. Find common denominator
2. Subtract the numerators
3. Place numerators over common denominator
4. Reduce to lowest terms

Example: $\frac{2}{3} - \frac{1}{2}$

$$\frac{2}{3} = \frac{4}{6}$$

$$\frac{1}{2} = \frac{3}{6}$$

$$\frac{4}{6} - \frac{3}{6} = \frac{1}{6}$$

C. Mixed numbers

1. Change fractions to proper fractions, if necessary
2. Subtract the fractions

INFORMATION SHEET

3. Subtract the whole numbers

4. Reduce answer if possible

Examples: $5\frac{1}{3} - 3\frac{1}{2} =$

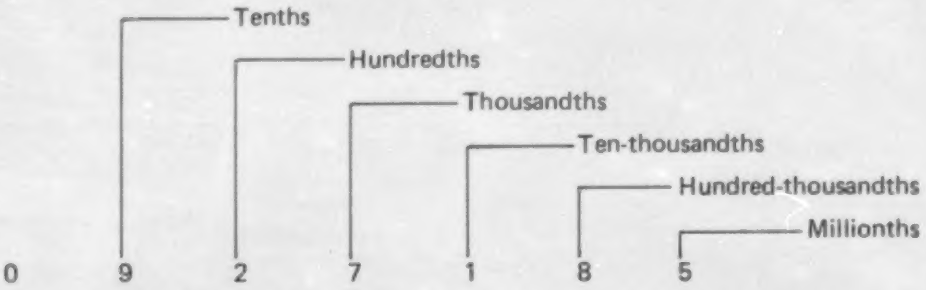
$$\frac{16}{3} - \frac{7}{2} = \frac{32}{6} - \frac{21}{6} = \frac{11}{6} = 1\frac{5}{6}$$

OR

$$\begin{array}{r} 5\frac{1}{3} = 5\frac{2}{6} = 4\frac{6}{6} + \frac{2}{6} = \quad 4\frac{8}{6} \\ -\ 3\frac{1}{2} = 3\frac{3}{6} = -3\frac{3}{6} = -\ 3\frac{3}{6} \\ \hline 1\frac{5}{6} \end{array}$$

(NOTE: Since 3/6 could not be subtracted from 2/6, you must borrow from the full number [5]. Change to 4 6/6. Then combine the fractions in the top number [4 6/6 + 2/6 = 4 8/6].)

XII. Place value of decimals


Tenths
Hundredths
Thousandths
Ten-thousandths
Hundred-thousandths
Millionths
0
9
2
7
1
8
5

Example: In the number above, the place values are

Tenth $= \frac{9}{10}$

Hundredths $= \frac{2}{100}$

Thousandths $= \frac{7}{1000}$

Ten-thousandths $= \frac{1}{10{,}000}$

Hundred-thousandths $= \frac{8}{100{,}000}$

Millionths $= \frac{5}{1{,}000{,}000}$

The number is read as nine-hundred-twenty-seven-thousand, one-hundred-eighty-five millionths (0.927185)

INFORMATION SHEET

XIII. Converting fractions to decimals (Assignment Sheet #17)

(NOTE: Fractions with ten, or a power of ten, as the denominator may be easily written as decimals.)

A. Allow as many decimal places as zeros in the denominator

B. Place a decimal point in front of the numerator and leave off the denominator

(NOTE: Zeros may be needed as *place holders*.)

Examples: $\frac{1}{10} = 0.1; \frac{3}{100} = 0.03; \frac{79}{100} = 0.79$

C. Write mixed numbers with the whole number to the left of the decimal point

Examples: $1\frac{1}{10} = 1.1$

$3\frac{7}{100} = 3.07$

XIV. Adding decimals (Assignment Sheet #18)

A. Write the given numbers in a column with the decimal points directly under each other

(NOTE: Whole numbers, such as 7 or 75 or 753, have *understood* decimal points, such as 7.00 or 75.00 or 753.00.)

B. Add each column of numbers the same as for regular whole numbers

C. Locate the decimal point in the answer by placing it directly under the decimal points above

Example: 0.857 + 2.1 + 370.057 + 753 = 1126.014

$$\begin{array}{r} 0.857 \\ 2.1 \\ 370.057 \\ +\ 753. \\ \hline 1126.014 \end{array} \qquad \text{OR} \qquad \begin{array}{r} 0.857 \\ 2.100 \\ 370.057 \\ +\ 753.000 \\ \hline 1126.014 \end{array}$$

(NOTE: Zeros may be added so that each number has the same number of decimal places.)

XV. Subtracting decimals (Assignment Sheet #19)

A. Solving problems

1. Write the given numbers so that the decimal points are under each other
2. Subtract each column of numbers the same as for regular whole numbers

INFORMATION SHEET

3. Locate the decimal point in the answer (difference) by placing it under the above decimal points

B. Checking problems

1. Add the answer (difference) and the number just above it

2. Notice that the sum must be the same as the top number in the problem for the answer to be correct

Example:

$$\begin{array}{r} 8.120 \\ -\,1.397 \\ \hline 6.723 \end{array} \qquad \text{Check} \quad \begin{array}{r} 1.397 \\ +\,6.723 \\ \hline 8.120 \end{array}$$

(NOTE: If problem contains a whole number, you may add as many zeros to the right of the decimal point as you need.)

XVI. Multiplying decimals (Assignment Sheet #20)

A. Multiply the same as whole numbers

(NOTE: In setting up multiplication problems, you do not need to place the decimal points in columns.)

B. Total the number of decimal places to the right of the decimal points in the factors being multiplied

C. Locate the decimal point by starting at the extreme right digit in the answer and counting off as many places to the left as the total found in step B indicates

Examples: Multiply 27.935 by 7.07

$$\begin{array}{rl} 27.935 & \text{-- 3 places} \\ \times\ 7.07 & \text{-- 2 places} \\ \hline 195545 & \\ 1955450 & \\ \hline 197.50045 & \text{-- 5 places} \end{array}$$

Multiply 2.31 by 0.041

$$\begin{array}{rl} 2.31 & \text{-- 2 places} \\ \times\ 0.041 & \text{-- 3 places} \\ \hline 231 & \\ 924 & \\ \hline 0.09471 & \text{-- 5 places} \end{array}$$

XVII. Dividing a decimal by a decimal (Assignment Sheet #21)

A. Count the number of digits to the right of the decimal point in the divisor

B. Place a caret (∧) at the end of the number

C. Count as many digits to the right of the decimal point in the dividend as you counted in the divisor

INFORMATION SHEET

D. Place a caret after the last digit you count

(NOTE: You may need to place some zeros in the dividend to the right of the last digit.)

E. Place the decimal point in the quotient directly above the caret in the dividend

F. Divide as with whole numbers

G. Check by multiplying the quotient and the divisor

Examples: $\begin{array}{r} 00.5 \\ 0.5_{\wedge}\overline{)\,0.2_{\wedge}5} \end{array}$ Check $\begin{array}{r} 0.5 \\ \times\,0.5 \\ \hline 0.25 \end{array}$

$\begin{array}{r} 5. \\ 0.05_{\wedge}\overline{)\,0.25_{\wedge}} \end{array}$ Check $\begin{array}{r} 0.05 \\ \times\,05 \\ \hline 0.25 \end{array}$

$0.005\overline{)\,0.25}$ becomes $\begin{array}{r} 50. \\ 0.005_{\wedge}\overline{)\,0.250_{\wedge}} \end{array}$ Check $\begin{array}{r} 0.005 \\ \times\;\;50 \\ \hline 0.250 \end{array}$

XVIII. Dividing a whole number by a decimal (Assignment Sheet #21)

A. Place a decimal point in the dividend at the right side of the number

B. Count the number of digits to the right of the decimal point in the divisor

C. Place a caret ($\wedge$) at the end of the number

D. Write as many zeros after the decimal point in the dividend as you counted places in the divisor

E. Place a caret after the last zero

F. Place a decimal point in the quotient directly above the caret in the dividend

G. Divide as with whole numbers

(NOTE: Zeros may need to be added beyond the caret if the division does not come out even.)

H. Check by multiplying the divisor and quotient

Example: $0.03\overline{)\,9}$ becomes $\begin{array}{r} 300. \\ 0.03_{\wedge}\overline{)\,9.00_{\wedge}} \end{array}$ Check $\begin{array}{r} 300 \\ \times\,0.03 \\ \hline 9.00 \end{array}$

INFORMATION SHEET

XIX. Converting fractions to decimals and percentages (Assignment Sheet #22)

A. Fractions as decimals--Divide the numerator by the denominator

Example: $\frac{5}{8}$

$$\begin{array}{r} 0.625 \\ 8\,\overline{)\,5.000} \\ \underline{48} \\ 20 \\ \underline{16} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

B. Fractions as percentages

1. Convert the fraction to decimal form
2. Move the decimal point two places to the right
3. Place the percent symbol (%) after the number

Example: $\frac{7}{33}$

$$\begin{array}{r} .2121 \\ 33\,\overline{)\,7.0000} \\ \underline{66} \\ 40 \\ \underline{33} \\ 70 \\ \underline{66} \\ 40 \\ \underline{33} \\ 7 \end{array} = 0.2121 = 21.21\%$$

(NOTE: Percent means that a number is a fraction of 100.)

XX. Converting percentages to fractions and decimals (Assignment Sheet #23)

A. Percentages as fractions

1. Drop the percent symbol (%)
2. Place the number over 100

(NOTE: Reduce to lowest terms.)

Examples: $38\% = \frac{38}{100} = \frac{19}{50}$

$33\frac{1}{3}\% = \frac{33\frac{1}{3}}{100} = \frac{\frac{100}{3}}{100} = \frac{1}{3}$

INFORMATION SHEET

B. Percentages as decimals

1. Drop the percent symbol (%)
2. Move the decimal point two places to the left

Examples: 74% = 0.74

$33\frac{1}{3}\% = 0.33$

XXI. Solving percentage problems (Assignment Sheets #24 and #25)

A. Write the unknown as "X"

(NOTE: The unknown may be the percent, the part, or the whole.)

B. Write all percentages as a fraction of 100

C. Make a fraction by placing the part over the whole amount

D. Write the two fractions with an equal sign between them

E. Cross multiply and solve the resulting equation

Examples: 16 (part) is what percent of 80 (whole)?

$$\frac{16}{80} = \frac{x}{100}$$

$80x = 1600$ (Divide 80 into 1600)

$x = 20\%$

5% of 97.3 is what number?

$$\frac{5}{100} = \frac{x}{97.3}$$

$100x = 486.5$ (Divide 100 into 486.5 or move the decimal point two places to the left)

$x = 4.865$

26 is 40% of what number?

$$\frac{26}{x} = \frac{40}{100}$$

$40x = 2600$ (Divide 40 into 2600)

$x = 65$

INFORMATION SHEET

XXII. Decimal and fractional equivalents

Decimal Equivalents

1/64	.015625	33/64	.515625
1/32	.03125	17/32	.53125
3/64	.046875	35/64	.546875
1/16	.0625	9/16	.5625
5/64	.078125	37/64	.578125
3/32	.09375	19/32	.59375
7/64	.109375	39/64	.609375
1/8	.125	5/8	.625
9/64	.140625	41/64	.640625
5/32	.15625	21/32	.65625
11/64	.171875	43/64	.671875
3/16	.1875	11/16	.6875
13/64	.203125	45/64	.703125
7/32	.21875	23/32	.71875
15/64	.234375	47/64	.734375
1/4	.25	3/4	.75
17/64	.265625	49/64	.765625
9/32	.28125	25/32	.78125
19/64	.296875	51/64	.796875
5/16	.3125	13/16	.8125
21/64	.328125	53/64	.828125
11/32	.34375	27/32	.84375
23/64	.359375	55/64	.859375
3/8	.375	7/8	.875
25/64	.390625	57/64	.890625
13/32	.40625	29/32	.90625
27/64	.421875	59/64	.921875
7/16	.4375	15/16	.9375
29/64	.453125	61/64	.953125
15/32	.46875	31/32	.96875
31/64	.484375	63/64	.984375
1/2	.5	1	1.

BASIC MATH
UNIT I

ASSIGNMENT SHEET #1--SOLVE ONE-DIGIT ADDITION PROBLEMS

NAME ______________________________ SCORE ____________

Like most people, you probably use addition every day. Today, for example you may have added coins together to pay for a cup of coffee or a snack. Every time you add, you use some basic addition facts. The numbers that are added together are called *addends*. The answer obtained in the addition problem is called the *sum* or *total*.

Although this exercise is a very simple one, it will form part of your math background and serve as the basis for completing further exercises or problems.

Example: $\begin{array}{r} 4 \\ +8 \\ \hline 12 \end{array}$

Solve each of the addition problems below for the sum or total.

1.	a. $\begin{array}{r} 7 \\ +1 \\ \hline \end{array}$	b. $\begin{array}{r} 2 \\ +9 \\ \hline \end{array}$	c. $\begin{array}{r} 2 \\ +5 \\ \hline \end{array}$	d. $\begin{array}{r} 2 \\ +8 \\ \hline \end{array}$	e. $\begin{array}{r} 4 \\ +4 \\ \hline \end{array}$	f. $\begin{array}{r} 4 \\ +1 \\ \hline \end{array}$	g. $\begin{array}{r} 3 \\ +1 \\ \hline \end{array}$
	h. $\begin{array}{r} 3 \\ +3 \\ \hline \end{array}$	i. $\begin{array}{r} 1 \\ +1 \\ \hline \end{array}$	j. $\begin{array}{r} 9 \\ +2 \\ \hline \end{array}$	k. $\begin{array}{r} 8 \\ +8 \\ \hline \end{array}$	l. $\begin{array}{r} 8 \\ +3 \\ \hline \end{array}$	m. $\begin{array}{r} 1 \\ +6 \\ \hline \end{array}$	n. $\begin{array}{r} 9 \\ +8 \\ \hline \end{array}$
2.	a. $\begin{array}{r} 1 \\ +9 \\ \hline \end{array}$	b. $\begin{array}{r} 0 \\ +5 \\ \hline \end{array}$	c. $\begin{array}{r} 8 \\ +1 \\ \hline \end{array}$	d. $\begin{array}{r} 6 \\ +6 \\ \hline \end{array}$	e. $\begin{array}{r} 0 \\ +4 \\ \hline \end{array}$	f. $\begin{array}{r} 3 \\ +6 \\ \hline \end{array}$	g. $\begin{array}{r} 0 \\ +2 \\ \hline \end{array}$
	h. $\begin{array}{r} 3 \\ +8 \\ \hline \end{array}$	i. $\begin{array}{r} 3 \\ +4 \\ \hline \end{array}$	j. $\begin{array}{r} 3 \\ +9 \\ \hline \end{array}$	k. $\begin{array}{r} 2 \\ +3 \\ \hline \end{array}$	l. $\begin{array}{r} 3 \\ +5 \\ \hline \end{array}$	m. $\begin{array}{r} 8 \\ +3 \\ \hline \end{array}$	n. $\begin{array}{r} 5 \\ +8 \\ \hline \end{array}$

3. Find total height of a building if the first floor is 29 ft., the second floor 18 ft., and the third floor 18 ft.

   Total height = ______________________ feet

ASSIGNMENT SHEET #1

4. If one side of a pool is 6 ft., another side is 4 ft., and the two ends are 3 ft. each, what is the perimeter?

Perimeter = ______________________________ feet

5. If you have to make a fill of 4 in. of sand, 6 in. of gravel, and 3 in. of soil, what is the total fill?

Total fill = ______________________________ inches

BASIC MATH
UNIT I

ASSIGNMENT SHEET #2–SOLVE TWO-DIGIT ADDITION PROBLEMS

NAME ________________________ SCORE ______________

In adding numbers with more than one digit, note that the digits on the left of the ones' column in no way affect the sum of the digits in the ones' column. Also, each of the problems below will require *carrying*.

Example: 1 ← carried figure
67
+ 25
92

7 + 5 = 12
Record the 2 and carry the 1
The carried 1 + 6 + 2 = 9
Record the 9

Solve each of the following addition problems for the sum or total.

1.	a. 49 81 + 27	b. 37 74 + 66	c. 92 38 + 77	d. 87 26 + 44	e. 44 57 + 63
2.	a. 28 41 + 82	b. 36 81 + 74	c. 67 38 + 43	d. 64 78 + 32	e. 72 38 + 25
3.	a. 72 38 + 25	b. 87 29 + 41	c. 26 17 + 84	d. 38 29 + 72	e. 41 59 + 67
4.	a. 82 78 32 18 96 + 54	b. 47 63 82 28 99 + 51	c. 74 36 45 87 23 + 45	d. 18 92 47 63 93 + 27	e. 75 48 35 62 51 + 48
5.	a. 17 23 36 45 82 90 + 41	b. 57 63 92 83 45 67 + 32	c. 13 93 62 56 98 87 + 60	d. 39 46 72 53 40 79 + 81	e. 32 87 40 79 53 62 + 81

ASSIGNMENT SHEET #2

6. How much concrete would it take for a job in which footings need 42 cubic yds., wall form 76 cubic yds., floors 38 cubic yds., and driveway 34 cubic yds.?

Total = ______________________________ cubic yards

7. How much weight was added to a roof when the brick weighed 150 lbs., sand 210 lbs., block 470 lbs., and mortar 520 lbs.?

Total = ______________________________ pounds

8. How much fuel was used in one day for all the equipment when grader used 20 gals., dozer used 22 gals., crane used 25 gals., backhoe used 32 gals., and lift used 16 gals.?

Total = ______________________________ gallons

BASIC MATH
UNIT I

ASSIGNMENT SHEET #3--SOLVE THREE-DIGIT ADDITION PROBLEMS

NAME ______________________ SCORE ______________

The more digits that you are adding, the more important it becomes to make small, legible figures and keep digits in straight columns. It may help to keep your pencil sharp and to always have an extra one.

Example:
539
333
+ 432
1304

2 + 3 + 9 = 14
Record the 4 and carry the 1
The carried 1 + 3 + 3 + 3 = 10
Record the 0 and carry the 1
The carried 1 + 4 + 3 + 5 = 13
Record the 13

Solve each of the addition problems below for the sum or total.

(NOTE: Do not forget the numerals that must be carried.)

1. a.	576	b.	333	c.	747	d.	909
	953		478		324		636
	462		962		600		877
	+ 615		+ 510		+ 598		+ 965
e.	396	f.	923	g.	327	h.	270
	728		934		240		368
	220		966		136		609
	+ 494		+ 123		+ 238		+ 224

2. In a certain house, a builder applied 528 square ft. of gypsum wall board in the kitchen, 640 square ft. in the living room, and 580 square ft. in the dining room. How many square feet did the builder apply?

Total = ______________________ square feet

ASSIGNMENT SHEET #3

3. If the first section of boom on a crane will reach 60 ft., the second 40 ft., the third 50 ft., and the fourth 30 ft., what would be the total height of the boom?

Total = ______________________________ feet

4. If a backhoe can dig 172 linear ft. the first day, 185 the second, 204 the third, 216 the fourth, and only 135 the fifth, how many linear feet will it dig in 5 days?

Total = ______________________________ linear feet

5. If one truck hauls 7 tons of gravel, another 12 tons, another 17 tons, another 23 tons, and a flat car 39 tons, how much gravel was hauled to this job?

Total = ______________________________ tons

BASIC MATH
UNIT I

ASSIGNMENT SHEET #4--SOLVE ONE-DIGIT SUBTRACTION PROBLEMS

NAME ______________________________ SCORE ______________

Addition is the first fundamental operation in mathematics. Subtraction, the process of finding the difference between two numbers, is the second fundamental operation.

Example: $\begin{array}{r}12\\-7\\\hline 5\end{array}$

Solve each of the subtraction problems below to find the difference or remainder.

1. a. 6 - 1 b. 2 - 1 c. 5 - 2 d. 6 - 3 e. 3 - 1 f. 7 - 1 g. 4 - 3
   h. 5 - 3 i. 5 - 4 j. 1 - 1 k. 8 - 1 l. 4 - 2 m. 6 - 6 n. 4 - 1
2. a. 9 - 6 b. 8 - 2 c. 10 - 4 d. 8 - 8 e. 9 - 3 f. 7 - 3 g. 6 - 0
   h. 6 - 2 i. 10 - 9 j. 10 - 1 k. 10 - 2 l. 7 - 6 m. 9 - 5 n. 8 - 7
3. a. 4 - 1 b. 2 - 2 c. 7 - 5 d. 6 - 4 e. 8 - 5 f. 13 - 6 g. 15 - 8
   h. 11 - 7 i. 11 - 5 j. 11 - 8 k. 9 - 2 l. 10 - 3 m. 14 - 7 n. 16 - 9

ASSIGNMENT SHEET #4

4. If it takes 31 bolts for a scraper frame and you already have 11 bolts, how many bolts will you need to buy?

Difference = ______________________________ bolts

5. If a pit measured 22 in. deep and had to be filled with 12 in. of sand, what would the finished depth be?

Difference = ______________________________ inches

BASIC MATH
UNIT I

ASSIGNMENT SHEET #5--SOLVE TWO-, THREE-, AND FOUR-DIGIT SUBTRACTION PROBLEMS

NAME ______________________________ SCORE ______________

Subtraction is the opposite of addition. You can check the accuracy of the answer obtained in a subtraction problem by simply adding the difference to the subtrahend. The sum of these two numbers must equal the minuend if the answer is correct.

Example: $\begin{array}{r} 57 \\ -35 \\ \hline 22 \end{array}$

Subtract 5 from 7 and record the 2
Subtract 3 from 5 and record the 2
Answer or difference is 22
Add 22 to 35 = 57
Answer is correct

Solve each of the following subtraction problems to find the difference or remainder; check your answers by adding the difference to the subtrahend.

1. a. $\begin{array}{r} 75 \\ -56 \\ \hline \end{array}$ b. $\begin{array}{r} 84 \\ -57 \\ \hline \end{array}$ c. $\begin{array}{r} 4635 \\ -3187 \\ \hline \end{array}$ d. $\begin{array}{r} 4178 \\ -1539 \\ \hline \end{array}$

2. a. $\begin{array}{r} 218 \\ -119 \\ \hline \end{array}$ b. $\begin{array}{r} 983 \\ -656 \\ \hline \end{array}$ c. $\begin{array}{r} 771 \\ -289 \\ \hline \end{array}$ d. $\begin{array}{r} 53 \\ -39 \\ \hline \end{array}$

3. a. $\begin{array}{r} 74 \\ -26 \\ \hline \end{array}$ b. $\begin{array}{r} 62 \\ -29 \\ \hline \end{array}$ c. $\begin{array}{r} 77 \\ -39 \\ \hline \end{array}$ d. $\begin{array}{r} 123 \\ -67 \\ \hline \end{array}$

4. a. $\begin{array}{r} 111 \\ -79 \\ \hline \end{array}$ b. $\begin{array}{r} 204 \\ -78 \\ \hline \end{array}$ c. $\begin{array}{r} 356 \\ -178 \\ \hline \end{array}$ d. $\begin{array}{r} 378 \\ -179 \\ \hline \end{array}$

5. a. $\begin{array}{r} 4890 \\ -362 \\ \hline \end{array}$ b. $\begin{array}{r} 365 \\ -209 \\ \hline \end{array}$ c. $\begin{array}{r} 6720 \\ -4890 \\ \hline \end{array}$ d. $\begin{array}{r} 7650 \\ -2312 \\ \hline \end{array}$

ASSIGNMENT SHEET #5

6. How much of a fill would have to be made on a road bed that is 47 in. low, and it was decided to fill it to 26 in. low?

Difference = ______________________________ inches

7. If the boom on a side boom is 18 ft. and you need 25 ft. to do a particular job, how much boom would have to be added?

Difference = ______________________________ feet

8. If a trenching machine dug 2,488 linear ft. the first day, and the operator needed to dig 8,572 linear ft. that week, how much more would have to be dug in the remaining four days?

Difference = ______________________________ linear feet

BASIC MATH
UNIT I

ASSIGNMENT SHEET #6--SOLVE ONE-DIGIT MULTIPLICATION PROBLEMS

NAME______________________________ SCORE ______________

Multiplication is the third basic operation in mathematics. It is a shortcut method of adding. For example, if you correctly add twelve 12's, the result will be 144, the same as 12 multiplied by 12.

Example: 7 x 8 = 56

$$\begin{array}{r} 8 \\ \underline{\times 7} \\ 56 \end{array}$$

Solve each of the following multiplication problems to find the products:

1.	a. 6 x2	b. 0 x4	c. 3 x6	d. 0 x2	e. 2 x4	f. 3 x0	g. 4 x5
	h. 9 x8	i. 6 x7	j. 8 x3	k. 8 x2	l. 6 x4	m. 1 x4	n. 9 x1
2.	a. 5 x6	b. 6 x6	c. 3 x2	d. 4 x3	e. 1 x5	f. 9 x9	g. 5 x5
	h. 2 x6	i. 9 x3	j. 8 x6	k. 6 x5	l. 3 x8	m. 3 x4	n. 3 x9
3.	a. 9 x3	b. 3 x5	c. 6 x3	d. 7 x3	e. 7 x7	f. 8 x7	g. 4 x8
	h. 8 x5	i. 9 x6	j. 5 x2	k. 4 x9	l. 1 x2	m. 5 x3	n. 8 x8

ASSIGNMENT SHEET #6

4.	a.	8	b.	5	c.	5	d.	7	e.	8	f.	7	g.	5
		x3		x9		x5		x7		x5		x9		x8
	h.	9	i.	6	j.	6	k.	7	l.	2	m.	2	n.	6
		x7		x8		x9		x6		x9		x5		x8
5.	a.	4	b.	4	c.	8	d.	6	e.	7	f.	9	g.	8
		x4		x8		x1		x6		x8		x9		x9
	h.	8	i.	7	j.	3	k.	6	l.	9	m.	8	n.	7
		x5		x7		x3		x7		x4		x5		x5

6. How many square feet in a sidewalk 9' long and 3' wide?

_______________________________ square feet

7. How many square feet of sand in a box 2' square by 8' high?

_______________________________ square feet

8. What is the total square foot area of a concrete pad 9' long by 8' wide?

_______________________________ square feet

ASSIGNMENT SHEET #6

9. If you need 8 oil filters for one dozer, how many would you need for 7 dozers?

________________________________ filters

10. If a mechanic can repair one engine in a 5 day week, how many days would it take to repair five engines?

________________________________ days

BASIC MATH
UNIT I

ASSIGNMENT SHEET #7–SOLVE MULTIPLICATION PROBLEMS WITH ONE-DIGIT MULTIPLIERS

NAME ______________________ SCORE ____________

Some multiplication problems involve *carrying*. You may write down the carried numerals, or simply remember them. Use the method that works better for you.

Example:

$$\begin{array}{r l} 1 \leftarrow & \text{Carried number} \\ 53 & 4 \times 3 = 12 \\ \uparrow & \text{Record the 2 and carry the 1} \\ \times\ 4 & \\ \hline 2 & \end{array}$$

$$\begin{array}{r l} 1 \leftarrow & \text{Carried number} \\ 53 & 4 \times 5 = 20 \\ \nwarrow & 20 + \text{the carried } 1 = 21 \\ \times\ 4 & \text{Record the 21} \\ \hline 212 & \text{Answer 212} \end{array}$$

Solve each of the following multiplication problems to find the products:

1. a. 53 x 4	b. 32 x 3	c. 26 x 4	d. 41 x 8	e. 57 x 4
2. a. 342 x 2	b. 453 x 5	c. 156 x 4	d. 703 x 5	e. 659 x 3
3. a. 3245 x 6	b. 1203 x 3	c. 2421 x 4	d. 5103 x 5	e. 4356 x 7
4. a. 481 x 7	b. 3758 x 6	c. 4256 x 4	d. 908 x 6	e. 3497 x 9

5. If I hauled 225 cubic yds. of sand per day how many cubic yds. could I haul in a week?

Product = ______________________ cubic yards

BASIC MATH
UNIT I

ASSIGNMENT SHEET #8--SOLVE MULTIPLICATION PROBLEMS WITH TWO- AND THREE-DIGIT MULTIPLIERS

NAME ______________________________ SCORE ______________

When multiplying by numbers which contain two or more digits, you must be careful to align the partial products properly. The right-hand digit of each partial product is written directly below the multiplying digit. This causes the partial products to be properly aligned so that the tens will be added to tens, hundreds to hundreds, etc.

Example:

```
      11 <------Carried numbers
     756
   x 312
    1512 <------First partial product
    756  <------Second partial product
   2268  <------Third partial product
 235,872 <------Product
```

Solve each of the multiplication problems below to find the products:

1. a. 63 x 38 b. 85 x 76 c. 32 x 59 d. 42 x 96 e. 73 x 64 f. 54 x 83

2. a. 95 x 74 b. 95 x 54 c. 67 x 43 d. 64 x 77 e. 82 x 77 f. 99 x 67

3. a. 556 x 554 b. 949 x 979 c. 262 x 192 d. 567 x 485 e. 879 x 729 f. 889 x 445

4. If a load of fill weighs 18,796 lbs., how much would 78 loads weigh?

Product = ______________________ pounds

5. If a dragline could stockpile 676 cubic yds. of dirt in two days, how much could be stockpiled in two weeks (7 day week)?

Product = ______________________ cubic yards

BASIC MATH
UNIT I

ASSIGNMENT SHEET #9--SOLVE DIVISION PROBLEMS WITH ONE-DIGIT DIVISORS

NAME ______________________________ SCORE ______________

Division is the fourth and last basic operation in mathematics. Multiplication puts together–division takes apart. Division is really the reverse of multiplication.

Example: $972 \div 3 = 324$

```
     324
  3) 972
     9
     --
      7
      6
     --
      12
      12
     --
```

Solve each of the division problems below to find the quotient:

(NOTE: You can check your own answers to division problems by multiplying.)

1. $3\overline{)6}$
2. $7\overline{)21}$
3. $5\overline{)225}$
4. $6\overline{)3600}$
5. $5\overline{)5}$
6. $4\overline{)16}$
7. $8\overline{)96}$
8. $9\overline{)81}$

ASSIGNMENT SHEET #9

9. $56\overline{)728}$

10. $8\overline{)4080}$

11. $9\overline{)108}$

12. $8\overline{)136}$

13. $7\overline{)49}$

14. $7\overline{)749}$

15. $4\overline{)48}$

13. $9\overline{)819}$

17. $5\overline{)830}$

18. $6\overline{)6702}$

19. $7\overline{)2884}$

20. $9\overline{)279}$

BASIC MATH
UNIT I

ASSIGNMENT SHEET #10--SOLVE LONG-DIVISION PROBLEMS

NAME______________________________ SCORE ________________

Long division is the name used for division by numbers that cannot readily be used as simple divisors. The individual products and remainders, because of their length, are written.

Example: 5678 ÷ 51 = 111 R (remainder) 17

$$\begin{array}{rl} 111 & \leftarrow \text{quotient} \\ 51\overline{)5678} & \\ \underline{51} & \\ 57 & \\ \underline{51} & \\ 68 & \\ \underline{51} & \\ 17 & \leftarrow \text{remainder} \end{array}$$

Solve each of the division problems below to find the quotient:

1. a. $12\overline{)24}$ b. $30\overline{)90}$ c. $66\overline{)198}$

2. a. $15\overline{)60}$ b. $23\overline{)276}$ d. $19\overline{)152}$

ASSIGNMENT SHEET #10

3. a. $86\overline{)1032}$ b. $11\overline{)121}$ c. $66\overline{)198}$

4. a. $52\overline{)468}$ b. $73\overline{)1095}$ c. $20\overline{)400}$

5. a. $47\overline{)1175}$ b. $79\overline{)632}$ c. $99\overline{)396}$

6. a. $26\overline{)8507}$ b. $62\overline{)7739}$ c. $28\overline{)5212}$

ASSIGNMENT SHEET #10

7. a. $34\overline{)5950}$ b. $17\overline{)8364}$ c. $71\overline{)18318}$

8. a. $43\overline{)10965}$ b. $56\overline{)7616}$ c. $92\overline{)30084}$

9. a. $37\overline{)26679}$ b. $7\overline{)4228}$ c. $15\overline{)24090}$

10. a. $15\overline{)4530}$ b. $26\overline{)52260}$ c. $13\overline{)91169}$

ASSIGNMENT SHEET #10

11. a. $34\overline{)17238}$ b. $36\overline{)10080}$ d. $17\overline{)53040}$

12. If a forklift travels 4,572 miles a year, how far would it travel in one month?

Quotient = ______________________________ miles

13. If the distance across a ravine was 12,940 ft., and the equipment could only move 9 ft. per day, how long would it take for the equipment to cross?

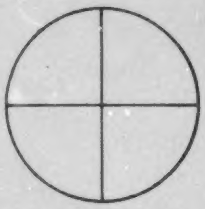
Quotient = ______________________________ days

BASIC MATH
UNIT I

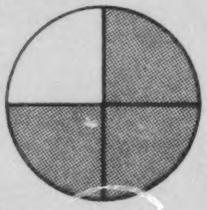
ASSIGNMENT SHEET #11--WORK WITH FRACTIONS

NAME ______________________________ SCORE ______________

When something is divided into parts that are all the same size, or equal size, it is divided into fractional parts. For example, the circle below is divided into four fractional parts.



To talk about fractional parts, you use fractions. For example, one of the four parts of the circle is unshaded, or 1/4 of the circle is unshaded; three of the four parts of the circle are shaded, or 3/4 of the circle is shaded.



In the fraction 3/4, the 4 is called the *denominator*. It shows the number of equal parts into which the circle is divided. The 3 is called the *numerator*. It shows the number of parts that are used.

PART I:

1. In the following fractions identify the numerator and denominator of each by filling in the blanks.
    a. In the fraction 5/7, the numerator is ________ and the denominator is __________
    b. In the fraction 8/18, 8 is the ______________ and 18 is the ______________
    c. In the fraction 1/3, what is the numerator? __________ denominator? __________
2. Write fractions which fit the following statements.
    a. A fraction with a denominator of 17 and numerator of 10 ______________
    b. A fraction with a numerator of 16 and a denominator of 37 ______________

ASSIGNMENT SHEET #11

3. A man cuts a piece of sheet metal into 8 equal pieces and then destroys 1 of the 8 pieces.

   a. Which number represents the numerator?____________________

   b. Which number represents the denominator?____________________

   c. What fractional part of the sheet metal did the man destroy?____________

PART II:

1. Match the fractions with the correctly shaded figures. There are more figures than there are fractions.

_____a. $\frac{4}{8}$

_____b. $\frac{2}{2}$

_____c. $\frac{6}{16}$

_____d. $\frac{3}{7}$

_____e. $\frac{5}{5}$

_____f. $\frac{1}{2}$

_____g. $\frac{2}{7}$

_____h. $\frac{5}{6}$

_____i. $\frac{1}{4}$

_____j. $\frac{2}{3}$

_____k. $\frac{7}{8}$

_____l. $\frac{3}{5}$

_____m. $\frac{2}{8}$

_____n. $\frac{3}{3}$

_____o. $\frac{1}{5}$

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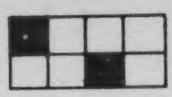

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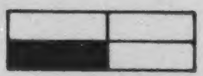

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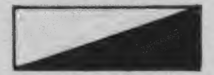

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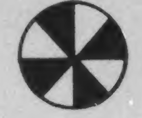

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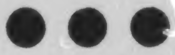

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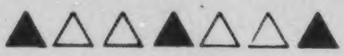

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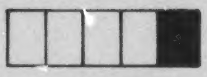

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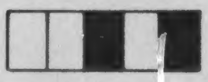

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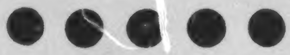

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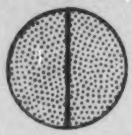

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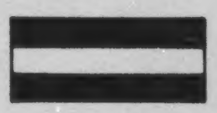

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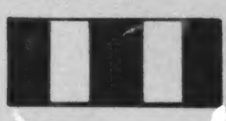

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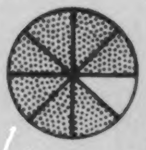

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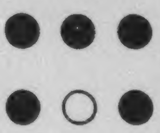

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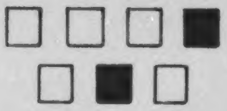

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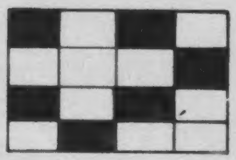
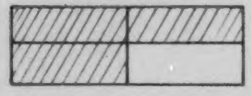


ASSIGNMENT SHEET #11

2. Draw a suitable figure to represent each of the following fractions.

Example: $\frac{3}{4}$



a. $\frac{1}{2}$

b. $\frac{3}{4}$

c. $\frac{2}{3}$

d. $\frac{1}{4}$

e. $\frac{7}{8}$

f. $\frac{5}{16}$

g. $\frac{3}{3}$

h. $\frac{2}{4}$

i. $\frac{3}{8}$

j. $\frac{13}{16}$

BASIC MATH
UNIT I

ASSIGNMENT SHEET #12--CONVERT FRACTIONS

NAME ______________________________ SCORE ______________

A fraction like 3/4 is called a *proper fraction*. This is because the numerator (top number) is smaller than the denominator (bottom number). Some examples of proper fractions are 2/3, 1/5, and 7/8.

When the numerator of a fraction is the same, or larger, than the denominator, the fraction is called an *improper fraction*. Some examples of improper fractions are 4/4, 5/3, 9/4, and 10/8.

Numbers such as 2 1/2, 5 3/4, and 6 2/5 are called *mixed numbers*. They are made up of a whole number and a fraction.

PART I:

1. Distinguish among the following fractions by placing "P" for proper fraction, "I" for improper fraction, or "M" for mixed number in the blank to the left.

_____a. $\frac{1}{2}$

_____b. $\frac{7}{8}$

_____c. $\frac{16}{2}$

_____d. $3\frac{1}{8}$

_____e. $\frac{1}{4}$

_____f. $\frac{1}{1}$

_____g. $\frac{7}{3}$

_____h. $8\frac{1}{3}$

_____i. $\frac{4}{4}$

_____j. $9\frac{2}{3}$

_____k. $5\frac{1}{2}$

_____l. $\frac{9}{8}$

_____m. $\frac{9}{9}$

_____n. $\frac{1}{7}$

_____o. $16\frac{3}{4}$

2. Use the following denominators and fill in numerators to complete the following problems.

   a. Complete the following to make proper fractions:

      1) $\frac{\_\_\_}{8}$

ASSIGNMENT SHEET #12

2) $\frac{\quad}{10}$

3) $\frac{\quad}{7}$

4) $\frac{\quad}{2}$

5) $\frac{\quad}{30}$

b. Complete the following to make improper fractions:

1) $\frac{\quad}{3}$

2) $\frac{\quad}{5}$

3) $\frac{\quad}{6}$

4) $\frac{\quad}{9}$

5) $\frac{\quad}{4}$

ASSIGNMENT SHEET #12

PART II:

1. Convert each of the following mixed numbers to improper fractions. (Do not reduce answers to lowest terms at this time.)

a. $3\frac{1}{4} =$ ______

b. $4\frac{1}{2} =$ ______

c. $7\frac{1}{3} =$ ______

d. $8\frac{1}{2} =$ ______

e. $6\frac{2}{3} =$ ______

f. $5\frac{1}{5} =$ ______

g. $4\frac{2}{3} =$ ______

h. $8\frac{1}{7} =$ ______

i. $9\frac{1}{5} =$ ______

j. $16\frac{2}{3} =$ ______

k. $2\frac{1}{2} =$ ______

l. $3\frac{2}{4} =$ ______

m. $7\frac{3}{4} =$ ______

n. $9\frac{2}{3} =$ ______

o. $5\frac{2}{3} =$ ______

p. $6\frac{1}{8} =$ ______

q. $3\frac{3}{4} =$ ______

r. $6\frac{4}{5} =$ ______

s. $4\frac{1}{3} =$ ______

t. $1\frac{4}{5} =$ ______

2. Convert each of the following improper fractions to mixed numbers. (Do not reduce answers to lowest terms at this time.)

a. $\frac{16}{5} =$ ______

b. $\frac{12}{5} =$ ______

c. $\frac{17}{3} =$ ______

d. $\frac{8}{3} =$ ______

e. $\frac{9}{2} =$ ______

f. $\frac{5}{3} =$ ______

g. $\frac{7}{2} =$ ______

h. $\frac{9}{4} =$ ______

i. $\frac{17}{16} =$ ______

j. $\frac{11}{5} =$ ______

ASSIGNMENT SHEET #12

k. $\frac{19}{13}$ = ______

l. $\frac{8}{7}$ = ______

m. $\frac{75}{32}$ = ______

n. $\frac{24}{17}$ = ______

o. $\frac{13}{9}$ = ______

p. $\frac{7}{4}$ = ______

q. $\frac{9}{6}$ = ______

r. $\frac{4}{3}$ = ______

s. $\frac{15}{4}$ = ______

t. $\frac{16}{7}$ = ______

BASIC MATH
UNIT I

ASSIGNMENT SHEET #13--REDUCE FRACTIONS TO LOWEST TERMS

NAME ______________________________ SCORE ______________

Fractions are "reduced" to their lowest terms so that they are more readily understood or recognized. For example 1/2 is more easily recognized than 16/32.

To reduce a fraction to lowest terms, divide the numerator and the denominator by all divisors that are common to both.

Examples: $\frac{18}{24} \div \frac{2}{2} = \frac{9}{12}$

$\frac{9}{12} \div \frac{3}{3} = \frac{3}{4}$

Reduce the following fractions to lowest terms.

1. $\frac{3}{9} =$ _____
2. $\frac{8}{24} =$ _____
3. $\frac{10}{15} =$ _____
4. $\frac{15}{25} =$ _____
5. $\frac{12}{48} =$ _____
6. $\frac{9}{24} =$ _____
7. $\frac{5}{7} =$ _____
8. $\frac{2}{4} =$ _____
9. $\frac{9}{12} =$ _____
10. $\frac{50}{100} =$ _____
11. $\frac{5}{5} =$ _____
12. $\frac{8}{12} =$ _____
13. $\frac{7}{21} =$ _____
14. $\frac{4}{8} =$ _____
15. $\frac{10}{12} =$ _____
16. $\frac{26}{52} =$ _____
17. $\frac{6}{9} =$ _____
18. $\frac{13}{39} =$ _____
19. $\frac{9}{9} =$ _____
20. $\frac{12}{16} =$ _____

BASIC MATH
UNIT I

ASSIGNMENT SHEET #14--FIND COMMON DENOMINATORS

NAME ______________________________ SCORE ______________

In the addition of fractions, if the denominators are different, the fractions must be changed to equivalent fractions with a common denominator.

To change a fraction to its equivalent, multiply the denominator of the given fraction by the number that will give the desired denominator; then multiply the numerator of the fraction by the same multiplier.

Example: $\frac{1}{2} = \frac{}{8}$ $\frac{1}{2} \times \frac{4}{4} = \frac{4}{8}$ $\frac{1}{2} = \frac{4}{8}$

To change a fraction to its equivalent in a lower denomination, proceed in like manner, but divide, instead of multiply, both the denominator and the numerator by the same number.

Example: $\frac{12}{16} = \frac{}{4}$ $\frac{12}{16} \div \frac{4}{4} = \frac{3}{4}$ $\frac{12}{16} = \frac{3}{4}$

PART I

Convert each of the fractions below to equivalent fractions with a common denominator.

1. $\frac{1}{2} = \frac{}{12}$ $\frac{2}{3} = \frac{}{12}$ $\frac{3}{4} = \frac{}{12}$ $\frac{5}{6} = \frac{}{12}$
2. $\frac{1}{4} = \frac{}{32}$ $\frac{5}{8} = \frac{}{32}$ $\frac{7}{8} = \frac{}{32}$ $\frac{9}{16} = \frac{}{32}$
3. $\frac{12}{16} = \frac{}{4}$ $\frac{18}{24} = \frac{}{4}$ $\frac{24}{32} = \frac{}{4}$ $\frac{42}{56} = \frac{}{4}$
4. $\frac{15}{48} = \frac{}{16}$ $\frac{25}{80} = \frac{}{16}$ $\frac{28}{64} = \frac{}{16}$ $\frac{18}{32} = \frac{}{16}$

PART II

Fractions that have the same denominator are said to have a common denominator.

Example: Find common denominator of $\frac{5}{6}$ and $\frac{3}{8}$

Common denominator of $\frac{5}{6}$ and $\frac{3}{8}$ is a common multiple of 6 and 8.

$\frac{5}{6}$ $\frac{3}{8}$

24 is a common multiple of 6 and 8
It is a common denominator of 5/6 and 3/8
24 is the lowest common multiple of 6 and 8
It is the lowest common denominator of 5/6 and 3/8

ASSIGNMENT SHEET #14

Find the lowest common denominator for each set of fractions

1. $\frac{7}{8}, \frac{5}{12}, \frac{3}{16}, \frac{17}{24}$ = ______

2. $\frac{3}{5}, \frac{5}{6}, \frac{9}{10}, \frac{4}{15}$ = ______

3. $\frac{1}{2}, \frac{5}{12}, \frac{2}{3}, \frac{3}{4}$ = ______

4. $\frac{3}{4}, \frac{5}{6}, \frac{12}{24}, \frac{40}{36}$ = ______

BASIC MATH
UNIT I

ASSIGNMENT SHEET #15--ADD FRACTIONS

NAME ______________________________ SCORE ______________

To add common fractions, change to equivalent fractions with lowest common denominators. Add the new numerators and place this sum over the lowest common denominator. If the result is an improper fraction, change it to a mixed number and reduce to lowest terms.

Example: $\frac{2}{3} + \frac{3}{4} =$

$$\frac{8}{12} + \frac{9}{12} = \frac{17}{12} = 1\frac{5}{12}$$

Find common denominators and add the following fractions. Reduce to lowest terms.

1. $\frac{1}{4} + \frac{2}{3} =$ _____ $\frac{3}{4} + \frac{5}{6} =$ _____

2. $\frac{4}{5} + \frac{3}{4} =$ _____ $\frac{5}{8} + \frac{5}{6} =$ _____

3. $\frac{5}{9} + \frac{4}{7} =$ _____ $\frac{2}{5} + \frac{4}{9} =$ _____

4. $\frac{7}{12} + \frac{5}{8} =$ _____ $\frac{3}{5} + \frac{2}{3} =$ _____

BASIC MATH
UNIT I

ASSIGNMENT SHEET #16--SUBTRACT FRACTIONS

NAME ______________________________ SCORE ______________

To subtract common fractions, change to equivalent fractions with common denominators. Find the difference between the numerators of the equivalent fractions. Place the difference over the common denominator and, if necessary, reduce the answer to lowest terms.

Example: $\frac{2}{3} - \frac{1}{4} =$

$\frac{8}{12} - \frac{3}{12} = \frac{5}{12}$

Subtract each of the common fractions given below. Reduce to lowest terms.

1. $\frac{3}{4} - \frac{2}{3} =$ _____ $\frac{2}{3} - \frac{1}{2} =$ _____

2. $\frac{7}{8} - \frac{2}{3} =$ _____ $\frac{4}{5} - \frac{3}{8} =$ _____

3. $\frac{4}{5} - \frac{5}{12} =$ _____ $\frac{9}{10} - \frac{2}{3} =$ _____

4. $\frac{5}{6} - \frac{5}{8} =$ _____ $\frac{6}{7} - \frac{5}{9} =$ _____

5. $\frac{5}{9} - \frac{3}{8} =$ _____ $\frac{1}{3} - \frac{5}{16} =$ _____

BASIC MATH
UNIT I

ASSIGNMENT SHEET #17--CONVERT FRACTIONS TO DECIMALS

NAME____________________________________ SCORE ____________

Common fractions can also be expressed as decimal fractions, called decimals.

$1\frac{5}{10} = 1.5 \rightarrow$ tenths

$1\frac{25}{100} = 1.25 \rightarrow$ hundredths

$1\frac{125}{1000} = 1.125 \rightarrow$ thousandths

1. Match the decimal notations on the right to the correct equivalent fractions.

_____a. $5\frac{6}{10}$

_____b. $1\frac{2}{100}$

_____c. $\frac{87}{1000}$

_____d. $7\frac{83}{1000}$

_____e. $5\frac{6}{100}$

_____f. $5\frac{6}{1000}$

_____g. $78\frac{3}{10}$

_____h. $87\frac{7}{10}$

_____i. 102

_____j. $\frac{783}{1000}$

1. 7.83
2. 5.006
3. 78.3
4. 0.087
5. 0.783
6. 87.7
7. 5.6
8. 102.0
9. 5.06
10. 1.02

ASSIGNMENT SHEET #17

2. Write the numbers in decimal notation for each of the following.

a. $63\frac{9}{10}=$ ____________________

b. $5\frac{93}{100}=$ ____________________

c. $5\frac{93}{1000}=$ ____________________

d. $5\frac{93}{10000}=$ ____________________

e. $3\frac{825}{1000}=$ ____________________

f. $38\frac{95}{100}=$ ____________________

g. $38\frac{95}{1000}=$ ____________________

h. $42\frac{3}{10}=$ ____________________

i. $402\frac{3}{10}=$ ____________________

j. $897\frac{97}{100000}=$ ____________________

BASIC MATH
UNIT I

ASSIGNMENT SHEET #18–SOLVE ADDITION PROBLEMS WITH DECIMALS

NAME ____________________ SCORE ____________

You can add decimals just as you add whole numbers. You must be careful, though, to keep all decimal points in a straight line.

Add each column of numbers, carrying when necessary. Place a decimal point in the sum directly under the above decimal points.

Examples:

$$\begin{array}{r} 0.26 \\ +\,0.168 \\ \hline 0.428 \end{array} \qquad \begin{array}{r} 4.607 \\ +\,.408 \\ \hline 5.015 \end{array}$$

1. $\begin{array}{r} 0.024 \\ +\,0.165 \\ \hline \end{array}$

2. $\begin{array}{r} 0.673 \\ +\,0.199 \\ \hline \end{array}$

3. $\begin{array}{r} 4.6 \\ +\,4.62 \\ \hline \end{array}$

4. $\begin{array}{r} 0.0003 \\ +\,0.0099 \\ \hline \end{array}$

5. $\begin{array}{r} 5.00 \\ +\,0.99 \\ \hline \end{array}$

6. $\begin{array}{r} 4.5 \\ +\,0.008 \\ \hline \end{array}$

7. $\begin{array}{r} 62.14 \\ +\,8.87 \\ \hline \end{array}$

8. $\begin{array}{r} 3.487 \\ +\,9.645 \\ \hline \end{array}$

9. $\begin{array}{r} 0.5 \\ 0.6 \\ +\,8.3 \\ \hline \end{array}$

10. $\begin{array}{r} 195.7 \\ 83. \\ +\;\;9.006 \\ \hline \end{array}$

11. $\begin{array}{r} 21.5 \\ 18.9 \\ +\,32.8 \\ \hline \end{array}$

12. $\begin{array}{r} 0.0131 \\ 0.1640 \\ +\,0.2229 \\ \hline \end{array}$

13. $\begin{array}{r} 8.69 \\ 3.07 \\ +\,17.50 \\ \hline \end{array}$

14. $\begin{array}{r} 4.612 \\ 0.958 \\ +\,0.885 \\ \hline \end{array}$

15. $\begin{array}{r} 5.29 \\ 4.38 \\ +\,9.62 \\ \hline \end{array}$

16. $\begin{array}{r} 72.24 \\ 16.38 \\ +\,92.37 \\ \hline \end{array}$

17. $\begin{array}{r} 1986.45 \\ 312.45 \\ +\,1000.98 \\ \hline \end{array}$

18. $\begin{array}{r} 4937.23 \\ 4980.47 \\ 10234.97 \\ +\;\;9872.21 \\ \hline \end{array}$

19. $\begin{array}{r} 0.52802 \\ 0.34007 \\ 0.00321 \\ +\,0.00009 \\ \hline \end{array}$

20. $\begin{array}{r} 15.125 \\ 4.625 \\ 20.125 \\ +\,16.125 \\ \hline \end{array}$

BASIC MATH
UNIT I

ASSIGNMENT SHEET #19--SOLVE SUBTRACTION PROBLEMS WITH DECIMALS

NAME ______________________________ SCORE ______________

When you subtract decimals, decimal points must also be kept in a straight line.

Rewrite each of these problems in column form. Subtract and check your work.

1. 868.87 - 516.89 = ______________

2. 567 - 19.856 = ______________

3. 198 - 56.987 = ______________

4. 567.94 - 59.78 = ______________

5. $815.23 - $65.98 = ______________

6. $20.03 - $15.88 = ______________

ASSIGNMENT SHEET #19

7. 694.7 - 24.3 = ________________

8. 5,000 - 892.66 = ________________

9. $15 - $12.53 = ________________

10. 219.3 - 0.085 = ________________

11. 16.78 - 5.99 = ________________

12. 1.6 - 0.9453 = ________________

13. 2.345 - 1.6 = ________________

ASSIGNMENT SHEET #19

14. 0.13 - 0.023 = ________________

15. 0.00754 - 0.00093 = ________________

16. 20.32 - 0.84 = ________________

17. 930 - 17.45 = ________________

18. 0.034 - 0.034 = ________________

19. 1 - 0.9999 = ________________

20. 7.777 - 0.777 = ________________

BASIC MATH
UNIT I

ASSIGNMENT SHEET #20--SOLVE MULTIPLICATION PROBLEMS WITH DECIMALS

NAME ______________________________ SCORE ______________

Multiplication with decimals is like multiplication with whole numbers. However, with decimals you must be careful where you place the decimal point. The number of decimal places in an answer must equal the total number of decimal places in the numbers that you multiplied.

```
Example:   16.11  -- 2 decimal places
           x 2.2  -- 1 decimal place
           -----
            3222
           3222
          ------
          35.442  -- 3 decimal places in answer
```

Rewrite in column form and multiply these problems. Locate the decimal point in the product.

1. 2.64 x 3.1 = ______________

2. 120 x 0.33 = ______________

3. 2.25 x 0.51 = ______________

4. 35 x 8.5 = ______________

5. 26.4 x 3.8 = ______________

6. 7.02 x 0.92 = ______________

7. 0.83 x 0.55 = ______________

8. 28.2 x 0.9 = ______________

ASSIGNMENT SHEET #20

9. 0.069 x 0.01 = ________________

10. 7.52 x 3.01 = ________________

11. 32.1 x 29.9 = ________________

12. 0.168 x 12 = ________________

13. 78 x 9.1 = ________________

14. 69.3 x 0.75 = ________________

15. 0.043 x 2.4 = ________________

16. 574 x 0.34 = ________________

17. 10.52 x 0.54 = ________________

18. 9.06 x 4.3 = ________________

19. 21.6 x 0.3 = ________________

20. 60.1 x 8.2 = ________________

BASIC MATH
UNIT I

ASSIGNMENT SHEET #21–SOLVE DIVISION PROBLEMS WITH DECIMALS

NAME ____ SCORE ________________

Division with decimals is like division with whole numbers. However, before you begin to divide, you must decide where the decimal point should be placed in the number.

First study the number by which you are dividing. If that number is a decimal, move the decimal point to the right so that you change the decimal to a whole number. Then move the decimal point the same number of places to the right in the number into which you are dividing.

Examples: Decimal point moved 1 place in both numbers

$$\begin{array}{r} . \\ \underset{\curvearrowright}{.2.}\overline{)\,\underset{\curvearrowright}{.4.}} \end{array} \qquad \begin{array}{r} 2. \\ 2.\overline{)\,4.} \\ \underline{4} \\ 0 \end{array}$$

Decimal point moved 2 places in both numbers

$$\begin{array}{r} . \\ \underset{\curvearrowright}{.14.}\overline{)\,14.\underset{\curvearrowright}{02.}8} \end{array} \qquad \begin{array}{r} 100.2 \\ 14.\overline{)\,1402.8} \\ \underline{14} \\ 0028 \\ \underline{28} \\ 0 \end{array}$$

Decimal point moved 1 place in both numbers;
note that a zero had to be added

$$\begin{array}{r} . \\ \underset{\curvearrowright}{1.3.}\overline{)\,26.\underset{\curvearrowright}{0.}} \end{array} \qquad \begin{array}{r} 20. \\ 13.\overline{)\,260.} \\ \underline{26} \\ 0 \end{array}$$

No decimal point was moved to the right since
3 is already a whole number

$$\begin{array}{r} . \\ 3\overline{)\,.6} \end{array} \qquad \begin{array}{r} .2 \\ 3\overline{)\,.6} \\ \underline{6} \\ 0 \end{array}$$

ASSIGNMENT SHEET #21

Divide the following problems. Show your work. Check your answers.

1. 4.5 ÷ 0.5 = ______

2. 4.96 ÷ 0.4 = ______

3. 19.8 ÷ 0.6 = ______

4. 10.71 ÷ 0.07 = ______

5. 0.225 ÷ 0.15 = ______

6. 1.7608 ÷ 0.0062 = ______

ASSIGNMENT SHEET #21

7. 0.48 ÷ 0.6 = ______

8. 0.125 ÷ 0.25 = ______

9. 0.9 ÷ 0.003 = ______

10. 1.16 ÷ 2.9 = ______

11. 75 ÷ 0.03 = ______

12. 108 ÷ 0.09 = ______

ASSIGNMENT SHEET #21

13. 84÷0.007 = ______

14. 459÷2.7 = ______

15. 64÷0.16 = ______

16. 125÷0.25 = ______

17. 34÷8.5 = ______

18. 6÷0.12 = ______

ASSIGNMENT SHEET #21

19. 406÷0.029 = ______

20. 8433÷0.09 = ______

BASIC MATH
UNIT I

ASSIGNMENT SHEET #22–WRITE FRACTIONS AS DECIMALS AND PERCENTAGES

NAME ______________________________ SCORE ______________

In practical math, percentage is often useful. Percent means per hundredths. Five percent means five one-hundredths and may be written three ways: 5/100, 0.05, and 5%. ALL HAVE THE SAME MATHEMATICAL VALUE.

1. Express each fraction as a decimal.

   a. $\frac{1}{8} =$ ________

   b. $\frac{1}{4} =$ ________

   c. $\frac{1}{2} =$ ________

   d. $\frac{3}{4} =$ ________

   e. $\frac{5}{8} =$ ________

   f. $\frac{7}{20} =$ ________

   g. $\frac{7}{16} =$ ________

   h. $\frac{1}{9} =$ ________

   i. $\frac{4}{9} =$ ________

   j. $\frac{4}{5} =$ ________

2. Express each fraction as a percentage.

   a. $\frac{1}{4} =$ ________

   b. $\frac{2}{9} =$ ________

ASSIGNMENT SHEET #22

c. $\frac{7}{10}$ = ________

d. $\frac{3}{4}$ = ________

e. $\frac{2}{2}$ = ________

f. $\frac{9}{11}$ = ________

g. $\frac{1}{3}$ = ________

h. $\frac{4}{9}$ = ________

i. $\frac{2}{6}$ = ________

j. $\frac{5}{8}$ = ________

BASIC MATH
UNIT I

ASSIGNMENT SHEET #23--WRITE PERCENTAGES AS FRACTIONS AND DECIMALS

NAME ______________________________ SCORE ______________

1. Express each percentage as a fraction.
   a. 50% = ________
   b. 25% = ________
   c. $33\frac{1}{3}\%$ = ________
   d. 36% = ________
   e. 28% = ________
   f. $14\frac{2}{7}\%$ = ________
   g. 21% = ________
   h. 45% = ________
   i. $66\frac{2}{3}\%$ = ________
   j. 70% = ________
2. Express each percentage as a decimal.
   a. 47% = ________
   b. 15% = ________
   c. 33.3% = ________
   d. 62% = ________
   e. 75% = ________
   f. 3% = ________
   g. 16.8% = ________
   h. 9% = ________
   i. 10% = ________
   j. 50% = ________

BASIC MATH
UNIT I

ASSIGNMENT SHEET #24–SOLVE PERCENTAGE PROBLEMS

NAME ______________________________ SCORE ____________

1. What does it mean to say 100 percent of the work is completed? ____________
____

2. There are usually 100 tools in the tool crib. Fourteen of them are missing. What percent of the tools is missing? ______________________

3. If 14 of the tools are missing in the above problem, how many are present? ________
What percent is present? ______________________

4. There are 100 bolts in a box. Twenty-five bolts are what percent of the bolts in the box? ______________________
Five bolts are what percent of the bolts in the box? ______________

5. There are 100 jobs on the agenda in a library. Ninety-four have been completed. What percent of the jobs has been completed? ______________

6. If 94 of the jobs in the above problem have been completed, how many have not been? ______________________
What percent has not been completed? ______________

7. If 11% of the students in a school are absent, what percent is present? ________

8. If 6% of the tires that a store had in stock were not sold, what percent was sold?
____

9. If 60% of the operators in town had licenses, what percent did not have licenses?
____

ASSIGNMENT SHEET #24

10. Byrl has a set of socket wrenches. Ten percent of his sockets are a year old, and 40% are over a year old. What percent is less than a year old? ____________________

11. Susan has three sizes of pliers--#1, #1 1/2, and #2. Eighty percent of her pliers are #1, and 15% are #1 1/2. What percent are #2? ____________________

12. The Smiths spent 22% of their income for their dozer: 17% for hand tools, 15% for work clothes, and 8% for beer. What percent was left for other things? ____________

13. Chester has finished 75% of the grading he is doing. What percent does he still have to do? ____________________

14. Betty has completed 40% of her rigging. What percent does she still have to do?

____

15. If you were told to complete 93% of the work, what percent would be left?

____

BASIC MATH
UNIT I

ASSIGNMENT SHEET #25–FIND PERCENTAGES OF WHOLE NUMBERS

NAME ______________________________ SCORE ______________

1. Solve each of the following problems.

   a. 3% of 72 is what number? ________

   b. 5% of 18 is what number? ________

   c. What number is $33\frac{1}{3}\%$ of 96? ________

   d. 40% of 125 is what number? ________

   e. 68% of 63.5 is what number? ________

   f. What number is $12\frac{1}{2}\%$ of 140.8? ________

   g. What number is 1% of 103? ________

   h. What number is $37\frac{1}{2}\%$ of 152? ________

   i. 50% of 32.8 is what number? ________

   j. 7% of 163 is what number? ________

ASSIGNMENT SHEET #25

2. Solve these word problems. Show your work.

   a. There are 20 students in a class. Sixty percent of the students are boys. How many are boys? ________________

   b. One day 5% of the 20 operators in Mr. Moore's group made perfect time completing a job. How many operators made perfect time? ________________

   c. Contractor McGill bought a new compressor--regularly selling for $120--at a sale and saved 20%. How much did he save? ________________

   d. The number of operators at the meeting this week was 75% of what it was last week. Last week there were 800 operators at the meeting. How many operators were at the meeting this week? ________________

ASSIGNMENT SHEET #25

e. Thirty-three and one-third percent of 150 safety forms have been filled out. How many forms have been filled out? ________________

f. What is 75% of 20? ________________

g. On one day only 65% of the 120 students in Highland Trade School were present. How many students were present? ________________

BASIC MATH
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1.	a.	8	2.	a.	10
	b.	11		b.	5
	c.	7		c.	9
	d.	10		d.	12
	e.	8		e.	4
	f.	5		f.	9
	g.	4		g.	2
	h.	6		h.	11
	i.	2		i.	7
	j.	11		j.	12
	k.	16		k.	5
	l.	11		l.	8
	m.	7		m.	11
	n.	17		n.	13

3. 65 feet
4. 16 feet
5. 13 inches

Assignment Sheet #2

1.	a.	157	2.	a.	151	3.	a.	135	4.	a.	360	5.	a.	334
	b.	177		b.	191		b.	157		b.	370		b.	439
	c.	207		c.	148		c.	127		c.	310		c.	469
	d.	157		d.	174		d.	139		d.	340		d.	410
	e.	164		e.	135		e.	167		e.	319		e.	434

6. 190 cubic yards
7. 1,350 pounds
8. 115 gallons

Assignment Sheet #3

1.	a.	2666	d.	3387	g.	941
	b.	2283	e.	1838	h.	1471
	c.	2269	f.	2946		

2. 1748 square feet
3. 180 feet
4. 912 linear feet
5. 98 tons

Assignment Sheet #4

1.	a.	5	2.	a.	3	3.	a.	3
	b.	1		b.	6		b.	0
	c.	3		c.	6		c.	2
	d.	3		d.	0		d.	2
	e.	2		e.	6		e.	3
	f.	6		f.	4		f.	7
	g.	1		g.	6		g.	7
	h.	2		h.	4		h.	4
	i.	1		i.	1		i.	6
	j.	0		j.	9		j.	3
	k.	7		k.	8		k.	7
	l.	2		l.	1		l.	7
	m.	0		m.	4		m.	7
	n.	3		n.	1		n.	7

4. 20 bolts
5. 10 inches

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #5

1. a. 19
   b. 27
   c. 1448
   d. 2639
2. a. 99
   b. 327
   c. 482
   d. 14
3. a. 48
   b. 33
   c. 38
   d. 56
4. a. 32
   b. 126
   c. 178
   d. 199
5. a. 4628
   b. 156
   c. 1830
   d. 5338
6. 21 in.
7. 7 ft.
8. 6,084 linear feet

Assignment Sheet #6

1. a. 12
   b. 0
   c. 18
   d. 0
   e. 8
   f. 0
   g. 20
   h. 72
   i. 42
   j. 24
   k. 16
   l. 24
   m. 4
   n. 9
2. a. 30
   b. 36
   c. 6
   d. 12
   e. 5
   f. 81
   g. 25
   h. 12
   i. 27
   j. 48
   k. 30
   l. 24
   m. 12
   n. 27
3. a. 27
   b. 15
   c. 18
   d. 21
   e. 49
   f. 56
   g. 32
   h. 40
   i. 54
   j. 10
   k. 36
   l. 2
   m. 15
   n. 64
4. a. 24
   b. 45
   c. 25
   d. 49
   e. 40
   f. 63
   g. 40
   h. 63
   i. 48
   j. 54
   k. 42
   l. 18
   m. 10
   n. 48
5. a. 16
   b. 32
   c. 8
   d. 36
   e. 56
   f. 81
   g. 72
   h. 40
   i. 49
   j. 9
   k. 42
   l. 36
   m. 40
   n. 35
6. 27 sq. ft.
7. 16 cu. ft.
8. 72 sq. ft.
9. 56 filters
10. 25 days

Assignment Sheet #7

1. a. 212
   b. 96
   c. 104
2. a. 684
   b. 2265
   c. 624
3. a. 19470
   b. 3609
   c. 9684
4. a. 3367
   b. 22548
   c. 17024

d. 328
e. 228

d. 3515
e. 1977

d. 25515
e. 30492

d. 5448
e. 31473

5. 1,575 cubic yards

Assignment Sheet #8

1. a. 2394
   b. 6460
   c. 1888
   d. 4032
   e. 4672
   f. 4482
2. a. 7030
   b. 5130
   c. 2881
   d. 4928
   e. 6314
   f. 6633
3. a. 308024
   b. 929071
   c. 50304
   d. 274995
   e. 640791
   f. 395605
4. 1,466,088 pounds
5. 4,732 cubic yards

Assignment Sheet #9

1. 2
2. 3
3. 45
4. 600
5. 1
6. 4
7. 12
8. 9
9. 13
10. 510
11. 12
12. 17
13. 7
14. 107
15. 12
16. 91
17. 166
18. 1117
19. 412
20. 31

Assignment Sheet #10

1. a. 2 b. 3 c. 3
2. a. 4 b. 12 c. 8
3. a. 12 b. 11 c. 3
4. a. 9 b. 15 c. 20
5. a. 25 b. 3 c. 4
6. a. 327, R 5
   b. 124, R 51
   c. 186, R 4

7. a. 175 b. 492 c. 258

8. a. 255 b. 136 c. 327

9. a. 721, R 2

b. 604

c. 1606

10. a. 302 b. 2010 c. 7013

11. a. 507 b. 280 c. 3120

12. 381 miles

13. $1{,}617\frac{1}{2}$ days

Assignment Sheet #11

PART I

1. a. 5, 7

b. numerator, denominator

c. 1, 3

2. a. $\frac{10}{17}$

b. $\frac{16}{37}$

3. a. 1

b. 8

c. $\frac{1}{8}$

PART II

1. a. 4 f. 3 k. 13

b. 10 g. 15 l. 12

c. 16 h. 14 m. 1

d. 6 i. 2 n. 5

e. 9 j. 11 o. 7

2. Evaluated to the satisfaction of the instructor

Assignment Sheet #12

PART I

1. a. P
   b. P
   c. I
   d. M
   e. P
   f. I
   g. I
   h. M
   i. I
   j. M
   k. M
   l. I
   m. I
   n. P
   o. M
2. Answers may vary
   a. Evaluated to the satisfaction of the instructor
   b. Evaluated to the satisfaction of the instructor

PART II

1. a. $\frac{13}{4}$
   b. $\frac{9}{2}$
   c. $\frac{22}{3}$
   d. $\frac{17}{2}$
   e. $\frac{20}{3}$
   f. $\frac{26}{5}$
   g. $\frac{14}{3}$
   h. $\frac{57}{7}$
   i. $\frac{46}{5}$
   j. $\frac{50}{3}$
   k. $\frac{5}{2}$
   l. $\frac{14}{4}$
   m. $\frac{31}{4}$
   n. $\frac{29}{3}$
   o. $\frac{17}{3}$
   p. $\frac{49}{8}$
   q. $\frac{15}{4}$
   r. $\frac{34}{5}$
   s. $\frac{13}{3}$
   t. $\frac{9}{5}$

2. a. $3\frac{1}{5}$
   b. $2\frac{2}{5}$
   c. $5\frac{2}{3}$
   d. $2\frac{2}{3}$
   e. $4\frac{1}{2}$
   f. $1\frac{2}{3}$
   g. $3\frac{1}{2}$
   h. $2\frac{1}{4}$
   i. $1\frac{1}{16}$
   j. $2\frac{1}{5}$
   k. $1\frac{6}{13}$
   l. $1\frac{1}{7}$
   m. $2\frac{11}{32}$
   n. $1\frac{7}{17}$
   o. $1\frac{4}{9}$
   p. $1\frac{3}{4}$
   q. $1\frac{3}{6}$
   r. $1\frac{1}{3}$
   s. $3\frac{3}{4}$
   t. $2\frac{2}{7}$

Assignment Sheet #13

1. $\frac{1}{3}$
2. $\frac{1}{3}$
3. $\frac{2}{3}$
4. $\frac{3}{5}$
5. $\frac{1}{4}$
6. $\frac{3}{8}$
7. $\frac{5}{7}$
8. $\frac{1}{2}$
9. $\frac{3}{4}$
10. $\frac{1}{2}$
11. 1
12. $\frac{2}{3}$
13. $\frac{1}{3}$
14. $\frac{1}{2}$
15. $\frac{5}{6}$
16. $\frac{1}{2}$
17. $\frac{2}{3}$
18. $\frac{1}{3}$
19. 1
20. $\frac{3}{4}$

Assignment Sheet #14

PART I

1. 6, 8, 9, 10
2. 8, 20, 28, 18
3. 3, 3, 3, 3
4. 5, 5, 7, 9

PART II

1. 48
2. 30
3. 12
4. 72

Assignment Sheet #15

1. $\frac{11}{12}$; $1\frac{7}{12}$
2. $1\ \frac{11}{20}$; $1\ \frac{11}{24}$
3. $1\frac{8}{63}$; $\frac{38}{45}$
4. $1\frac{5}{24}$; $1\frac{4}{15}$

Assignment Sheet #16

1. $\frac{1}{12}$; $\frac{1}{6}$
2. $\frac{5}{24}$; $\frac{17}{40}$
3. $\frac{23}{60}$; $\frac{7}{30}$
4. $\frac{5}{24}$; $\frac{19}{63}$
5. $\frac{13}{72}$; $\frac{1}{48}$

Assignment Sheet #17

1. a. 7
   b. 10
   c. 4
   d. 1
   e. 9
   f. 2
   g. 3
   h. 6
   i. 8
   j. 5
2. a. 63.9
   b. 5.93
   c. 5.093
   d. 5.0093
   e. 3.825
   f. 38.95
   g. 38.095
   h. 42.3
   i. 402.3
   j. 897.00097

Assignment Sheet #18

1. 0.189
2. 1.072
3. 9.22
4. 0.0102
5. 5.99
6. 4.508
7. 71.01
8. 13.132
9. 9.4
10. 287.706
11. 73.2
12. 0.4000
13. 29.26
14. 6.455
15. 19.29
16. 180.99
17. 3299.88
18. 30024.88
19. 0.87139
20. 56.000

Assignment Sheet #19

1. 351.98
2. 547.144
3. 141.013
4. 508.16
5. $749.25
6. $4.15
7. 670.4
8. 4107.34
9. $2.47
10. 219.215
11. 10.79
12. 0.6547
13. 0.745
14. 0.107
15. 0.00661
16. 19.48
17. 912.55
18. 0
19. 0.0001
20. 7.000

Assignment Sheet #20

1. 8.184
2. 39.6
3. 1.1475
4. 297.5
5. 100.32
6. 6.4584
7. 0.4565
8. 25.38
9. 0.00069
10. 22.6352
11. 959.79
12. 2.016
13. 709.8
14. 51.975
15. 0.1032
16. 195.16
17. 5.6808
18. 38.958
19. 6.48
20. 492.82

Assignment Sheet #21

1. 9
2. 12.4
3. 33
4. 153
5. 1.5
6. 284
7. 0.8
8. 0.5
9. 300
10. 0.4
11. 2500
12. 1200
13. 12,000
14. 170
15. 400
16. 500
17. 4
18. 50
19. 14,000
20. 93,700

Assignment Sheet #22

1. a. 0.125 f. 0.35
   b. 0.25 g. 0.4375
   c. 0.5 h. 0.111
   d. 0.75 i. 0.444
   e. 0.625 j. 0.80
2. a. 25% f. 81.81%
   b. 22.22% g. 33.33%
   c. 70% h. 44.44%
   d. 75% i. 33.33%
   e. 100% j. 62.5%

Assignment Sheet #23

1. a. $\frac{1}{2}$ f. $\frac{1}{7}$
   b. $\frac{1}{4}$ g. $\frac{21}{100}$
   c. $\frac{1}{3}$ h. $\frac{9}{20}$
   d. $\frac{9}{25}$ i. $\frac{2}{3}$
   e. $\frac{7}{25}$ j. $\frac{7}{10}$
2. a. 0.47 f. 0.03
   b. 0.15 g. 0.168
   c. 0.333 h. 0.09
   d. 0.62 i. 0.10
   e. 0.75 j. 0.50

Assignment Sheet #24

1. All work is completed
2. 14%
3. 86 - 86%
4. 25% - 5%
5. 94%
6. 6 - 6%
7. 89%
8. 94%
9. 40%
10. 50%
11. 5%
12. 38%
13. 25%
14. 60%
15. 7%

Assignment Sheet #25

1. a. 2.16
   b. 0.9
   c. 32
   d. 50
   e. 43.18
   f. 17.6
   g. 1.03
   h. 57
   i. 16.4
   j. 11.41
2. a. 12
   b. 1
   c. $24.00
   d. 600
   e. 50
   f. 15
   g. 78

BASIC MATH
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with basic math to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Any one of the ten symbols, 0 to 9, by which all numbers may be expressed

_____b. Opposite (inverse) operation of addition

_____c. An abbreviated process of adding an integer to itself a specified number of times

_____d. Any of the natural numbers; the whole numbers positive and negative

_____e. Opposite (inverse) operation of multiplication

_____f. Mathematical proposition

_____g. To solve by mathematical process

_____h. Part of a whole; represents one or more equal parts of a unit

_____i. Mark made to indicate where something is to be inserted

_____j. Fractions based on the number 10; not written as common fractions

_____k. Outer limits or boundary

_____l. One part in a hundred; reckoned on the basis of a whole divided into one hundred parts

_____m. First natural number

1. Integer
2. Caret (∧)
3. Division
4. Digit
5. Calculate
6. Decimals
7. Subtraction
8. Fraction
9. Problem
10. Multiplication
11. Percent
12. Unit
13. Perimeter

2. Match symbols used in math problems to the correct descriptions. Write the correct numbers in the blanks provided.

_____a. Addition

_____b. Subtraction

_____c. Division

_____d. Multiplication

1. ÷ $\overline{)\quad\quad}$
2. .
3. =
4. %

_____e. Equal	5. +
_____f. Decimal	6. ∧
_____g. Percent	7. ×
_____h. Caret	8. —

3. Solve the following addition problems.

a. $\begin{array}{r} 1 \\ 9 \\ 3 \\ +5 \\ \hline \end{array}$ b. $\begin{array}{r} 5 \\ 7 \\ 8 \\ 4 \\ +1 \\ \hline \end{array}$ c. $\begin{array}{r} 35 \\ 10 \\ 25 \\ +70 \\ \hline \end{array}$ d. $\begin{array}{r} 114 \\ 241 \\ 305 \\ +422 \\ \hline \end{array}$ e. $\begin{array}{r} 2706 \\ 4521 \\ 5134 \\ +7250 \\ \hline \end{array}$

4. Solve the following subtraction problems.

a. $\begin{array}{r} 9 \\ -3 \\ \hline \end{array}$ b. $\begin{array}{r} 8 \\ -2 \\ \hline \end{array}$ c. $\begin{array}{r} 44 \\ -4 \\ \hline \end{array}$ d. $\begin{array}{r} 89 \\ -7 \\ \hline \end{array}$ e. $\begin{array}{r} 87 \\ -52 \\ \hline \end{array}$

f. $\begin{array}{r} 342 \\ -128 \\ \hline \end{array}$ g. $\begin{array}{r} 1711 \\ -504 \\ \hline \end{array}$ h. $\begin{array}{r} 2990 \\ -2837 \\ \hline \end{array}$ i. $\begin{array}{r} 39082 \\ -8151 \\ \hline \end{array}$ j. $\begin{array}{r} 94584 \\ -2893 \\ \hline \end{array}$

5. Solve the following multiplications problems.

a. $\begin{array}{r} 7 \\ \times 5 \\ \hline \end{array}$ b. $\begin{array}{r} 10 \\ \times 9 \\ \hline \end{array}$ c. $\begin{array}{r} 212 \\ \times 3 \\ \hline \end{array}$ d. $\begin{array}{r} 42 \\ \times 21 \\ \hline \end{array}$ e. $\begin{array}{r} 510 \\ \times 34 \\ \hline \end{array}$

f. $\begin{array}{r} 122 \\ \times 15 \\ \hline \end{array}$ g. $\begin{array}{r} 178 \\ \times 141 \\ \hline \end{array}$ h. $\begin{array}{r} 428 \\ \times 319 \\ \hline \end{array}$ i. $\begin{array}{r} 1147 \\ \times 319 \\ \hline \end{array}$ j. $\begin{array}{r} 1215 \\ \times 500 \\ \hline \end{array}$

6. Solve the following division problems.

a. $5\overline{)40}$ b. $22\overline{)88}$ c. $42\overline{)320}$

b. $330\overline{)990}$ e. $452\overline{)1087}$ f. $641\overline{)16754}$

7. Distinguish among types of fractions. Write a "P" before proper, an "I" before improper, and an "M" before mixed fractions in the blanks provided.

______a. $\frac{1}{3}$

______b. $8\frac{1}{5}$

______c. $\frac{7}{7}$

______d. $15\frac{2}{3}$

______e. $5\frac{2}{7}$

______f. $\frac{10}{25}$

______g. $\frac{2}{5}$

______h. $6\frac{1}{2}$

______i. $\frac{1}{4}$

______j. $\frac{99}{1}$

8. Convert the following mixed numbers to improper fractions.

a. $3\frac{1}{2} =$ ______________________

b. $4\frac{2}{4} =$ ______________________

c. $3\frac{6}{9} =$ ______________________

d. $12\frac{4}{6} =$ ______________________

e. $13\frac{13}{39} =$ ______________________

9. Reduce the following fractions to lowest terms.

a. $\frac{4}{10} =$ ______________________

b. $\frac{8}{12} =$ ______________________

c. $\frac{7}{14} =$ ______________________

d. $\frac{8}{14} =$ ______________________

e. $\frac{12}{50} =$ ______________________

f. $\frac{4}{16} =$ ______________________

g. $\frac{2}{16} =$ ______________________

h. $\frac{8}{10} =$ ______________________

i. $\frac{12}{16} =$ ______________________

j. $\frac{121}{132} =$ ______________________

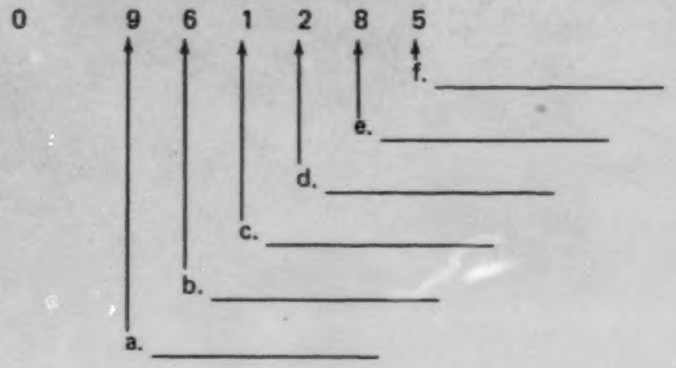
10. Add the following fractions.

- a. $\frac{1}{8}+\frac{5}{8}=$ ________________
- b. $\frac{1}{16}+\frac{15}{16}=$ ________________
- c. $\frac{2}{3}+\frac{3}{3}=$ ________________
- d. $\frac{1}{2}+\frac{4}{8}=$ ________________
- e. $\frac{4}{5}+\frac{2}{3}=$ ________________
- f. $\frac{7}{8}+\frac{6}{9}=$ ________________
- g. $2\frac{1}{3}+7\frac{1}{7}=$ ________________
- h. $3\frac{2}{4}+16\frac{1}{5}=$ ________________
- i. $4\frac{2}{7}+8\frac{2}{3}=$ ________________
- j. $5\frac{1}{5}+6\frac{2}{6}=$ ________________

11. Subtract the following fractions.

- a. $\frac{4}{5}-\frac{3}{5}=$ ________________
- b. $\frac{6}{8}-\frac{2}{8}=$ ________________
- c. $\frac{9}{13}-\frac{4}{13}=$ ________________
- d. $\frac{3}{6}-\frac{1}{3}=$ ________________
- e. $\frac{3}{8}-\frac{1}{3}=$ ________________
- f. $\frac{14}{16}-\frac{7}{8}=$ ________________
- g. $2\frac{3}{4}-1\frac{1}{4}=$ ________________
- h. $6\frac{1}{3}-2\frac{1}{2}=$ ________________
- i. $9\frac{2}{5}-4\frac{1}{2}=$ ________________
- j. $12\frac{6}{8}-7\frac{1}{3}=$ ________________

12. Write the place value of each of the decimals in the number 0.961285 below.



13. Convert the following fractions to decimals.

a. $23\frac{3}{100}$ = ____________________

b. $18\frac{3}{10}$ = ____________________

c. $5\frac{5}{1000}$ = ____________________

d. $8\frac{13}{100000}$ = ____________________

e. $11\frac{24}{1000000}$ = ____________________

14. Add the following decimals. Write in column form.

a. 3.5 + 5.1 + 7 = ____________________

b. 3.4 + 0.206 + 1.74 = ____________________

c. 6.86 + 0.0505 + 7.9 + 82 = ____________________

d. 57.78 + 0.22 + 0.003 + 74 = ____________________

e. 6,319 + 95.12 + 0.0713 + 321.07 = ____________________

15. Subtract the following decimals. Check your work.

a. 6.103 - 2.209 = ________________

b. 5.400 - 2.322 = ________________

c. 7.38 - 0.063 = ________________

d. 0.835325 - 0.25 = ________________

e. 0.609375 - 0.359375 = ________________

16. Multiply the following decimals.

a. 2.6 x 4.7 = ________________

b. 0.119 x 0.05 = ________________

c. 9 x 0.8 = ________________

d. 7.392 x 92.07 = ________________

e. 9.5 x 0.76 = ________________

17. Divide the following decimals by decimals. Check your work.

a. $0.4\overline{)5.32}$ b. $0.6\overline{)83.4}$ c. $0.765 \div 0.5 =$ ____________

d. $0.921 \div 0.3 =$ ____________ e. $0.0225 \div 0.15 =$ ____________

18. Divide the following whole numbers by decimals.

a. $24 \div 0.2 =$ ____________________

b. $54 \div 0.09 =$ ____________________

c. $63 \div 0.007 =$ ________________

d. $812 \div 0.058 =$ ________________

e. $4215 \div 0.040 =$ ________________

19. Convert the following fractions to decimals and percentages.

a. $\frac{1}{3} =$ ______________________________

b. $\frac{3}{25} =$ ______________________________

c. $\frac{7}{16} =$ ______________________________

d. $\frac{2}{7}$ = ______________________________

e. $\frac{5}{6}$ = ______________________________

20. Convert the following percentages to fractions and decimals.

a. 12% = ______________________________

b. 30% = ______________________________

c. 45% = ______________________________

d. 72% = ______________________________

e. 250% = ______________________________

21. Solve the following percentage problems.

a. If a motor with 150 horsepower runs with 87% efficiency, how much horsepower does it deliver? ______________________________

b. If anti-freeze evaporates 12% while in storage, how many barrels will be left of 2100 barrels placed in storage? ______________________________

c. If a contractor bought a tractor for $24,000, and sold it for $30,000, what was his percentage of profit? ______________________________

22. Complete the following chart on decimal and fractional equivalents.

Decimal Equivalents

$\frac{1}{64}$	.015625
$\frac{1}{32}$	.03125
$\frac{3}{64}$	.046875
$\frac{1}{16}$	.0625
$\frac{5}{64}$	.078125
$\frac{3}{32}$	.09375
$\frac{7}{64}$	.109375
a. ☐	.125
$\frac{9}{64}$	.140625
$\frac{5}{32}$	.15625
$\frac{11}{64}$	.171875
$\frac{3}{16}$	.1875
$\frac{13}{64}$	.203125
$\frac{7}{32}$	.21875
$\frac{15}{64}$	.234375
$\frac{1}{4}$	b. ______
$\frac{17}{64}$	.265625
$\frac{9}{32}$	.28125
$\frac{19}{64}$	.296875
$\frac{5}{16}$	.3125
$\frac{21}{64}$	.328125
$\frac{11}{32}$	.34375
$\frac{23}{64}$	.359375
c. ☐	.375
$\frac{25}{64}$	.390625
$\frac{13}{32}$	.40625
$\frac{27}{64}$	.421875
$\frac{7}{16}$	.4375
$\frac{29}{64}$	.453125
$\frac{15}{32}$	.46875
$\frac{31}{64}$	.484375
$\frac{1}{2}$	d. ______
$\frac{33}{64}$	.515625
$\frac{17}{32}$	.53125
$\frac{35}{64}$	.546875
$\frac{9}{16}$	.5625
$\frac{37}{64}$	.578125
$\frac{19}{32}$	.59375
$\frac{39}{64}$	.609375
$\frac{5}{8}$	e. ______
$\frac{41}{64}$	.640625
$\frac{21}{32}$	.65625
$\frac{43}{64}$	.671875
$\frac{11}{16}$	.6875
$\frac{45}{64}$	.703125
$\frac{23}{32}$	.71875
$\frac{47}{64}$	.734375
f. ☐	.75
$\frac{49}{64}$	.765625
$\frac{25}{32}$	.78125
$\frac{51}{64}$	.796875
$\frac{13}{16}$	.8125
$\frac{53}{64}$	.828125
$\frac{27}{32}$	.84375
$\frac{55}{64}$	.859375
$\frac{7}{8}$	g. ______
$\frac{57}{64}$	.890625
$\frac{29}{32}$	.90625
$\frac{59}{64}$	.921875
$\frac{15}{16}$	.9375
$\frac{61}{64}$	.953125
$\frac{31}{32}$	.96875
$\frac{63}{64}$	.984375
1	h. ______

BASIC MATH
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 7
   c. 10
   d. 1
   e. 3
   f. 9
   g. 5
   h. 8
   i. 2
   j. 6
   k. 13
   l. 11
   m. 12
2. a. 5
   b. 8
   c. 1
   d. 7
   e. 3
   f. 2
   g. 4
   h. 6
3. a. 18
   b. 25
   c. 140
   d. 1,082
   e. 19,611
4. a. 6
   b. 6
   c. 40
   d. 82
   e. 35
   f. 214
   g. 1,207
   h. 153
   i. 30,931
   j. 91,691

5. a. 35
   b. 90
   c. 636
   d. 882
   e. 17,340
   f. 1,830
   g. 25,098
   h. 136,532
   i. 365,893
   j. 607,500

6. a. 8
   b. 4
   c. 7, R 26
   d. 3
   e. 2, R 183
   f. 26, R 88

7. a. P
   b. M
   c. I
   d. M
   e. M
   f. P
   g. P
   h. M
   i. P
   j. I

8. a. $\frac{7}{2}$
   b. $\frac{18}{4}$
   c. $\frac{33}{9}$
   d. $\frac{76}{6}$
   e. $\frac{520}{39}$

9. a. $\frac{2}{5}$
   b. $\frac{2}{3}$
   c. $\frac{1}{2}$
   d. $\frac{4}{7}$
   e. $\frac{6}{25}$
   f. $\frac{1}{4}$
   g. $\frac{1}{8}$
   h. $\frac{4}{5}$
   i. $\frac{3}{4}$
   j. $\frac{11}{12}$

10. a. $\frac{3}{4}$

b. 1

c. $1\frac{2}{3}$

d. 1

e. $1\frac{7}{15}$

f. $1\frac{39}{72}$

g. $9\frac{10}{21}$

h. $19\frac{7}{10}$

i. $12\frac{20}{21}$

j. $11\frac{8}{15}$

11. a. $\frac{1}{5}$

b. $\frac{1}{2}$

c. $\frac{5}{13}$

d. $\frac{1}{6}$

e. $\frac{1}{24}$

f. 0

g. $1\frac{1}{2}$

h. $3\frac{5}{6}$

i. $4\frac{9}{10}$

j. $5\frac{5}{12}$

12. a. Tenths

b. Hundredths

c. Thousandths

d. Ten-thousandths

e. Hundred-thousandths

f. Millionths

13. a. 23.03
    b. 18.3
    c. 5.005
    d. 8.00013
    e. 11.000024

14.

a.	b.	c.	d.	e.
3.5	3.400	6.8600	57.780	6319.0000
5.1	0.206	0.0505	00.220	0095.1200
7.0	1.740	7.9000	00.003	0000.0713
15.6	5.346	82.0000	74.000	0321.0700
		96.8105	132.003	6735.2613

15. a. 3.894
    b. 3.078
    c. 7.317
    d. 0.585325
    e. 0.25

16. a. 12.22
    b. 0.00595
    c. 7.2
    d. 680.58144
    e. 7.22

17. a. 13.3
    b. 139
    c. 1.53
    d. 3.07
    e. 0.15

18. a. 120.
    b. 600.
    c. 9000.
    d. 14000.
    e. 105375.

19. a. 0.3333; $33\frac{1}{3}\%$

    b. 0.12; 12%

    c. 0.4375; $43\frac{3}{4}\%$

    d. 0.2857; $28\frac{57}{100}\%$

    e. 0.8333; $83\frac{1}{3}\%$

20. a. $\frac{3}{25}$; 0.12

    b. $\frac{3}{10}$; 0.30

    c. $\frac{9}{20}$; 0.45

    d. $\frac{18}{25}$; 0.72

    e. $\frac{5}{2}$; 2.50

21. a. 130.50 horsepower

    b. 1848 barrels

    c. 25%

22. a. $\frac{1}{8}$

    b. .25

    c. $\frac{3}{8}$

    d. .5

    e. .625

    f. $\frac{3}{4}$

    g. .875

    h. 1

PRACTICAL MATH
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to calculate practical math problems. This knowledge will be evidenced by completion of assignment sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with practical math to the correct definitions.
2. Match types of geometric figures to the correct descriptions.
3. Match units of measure to correct definitions.
4. Calculate area of geometric figures.
5. Calculate volume of solid figures.

PRACTICAL MATH
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

   A. Provide student with objective sheet.

   B. Provide student with information and assignment sheets.

   C. Discuss unit and specific objectives.

   D. Discuss information and assignment sheets.

   E. Give test.

II. Instructional materials:

   A. Objective sheet

   B. Information sheet

   C. Assignment sheets

      1. Assignment Sheet #1--Calculate Area of Squares

      2. Assignment Sheet #2--Calculate Area of Rectangles

      3. Assignment Sheet #3--Calculate Area of Circles

      4. Assignment Sheet #4--Calculate Area of Triangles

      5. Assignment Sheet #5--Calculate Area of Parallelograms

      6. Assignment Sheet #6--Calculate Area of Trapezoids

      7. Assignment Sheet #7--Count Cubic Units to Determine Volume

      8. Assignment Sheet #8--Determine Cubic Inches and Cubic Feet

      9. Assignment Sheet #9--Calculate Volume Using a Formula

      10. Assignment Sheet #10--Estimate Cubic Yards

   D. Answers to assignment sheets

   E. Test

   F. Answers to test

III. Unit reference--Hendrix, Laborn J., "Bud." *Millwright Instructional Materials.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

PRACTICAL MATH
UNIT II

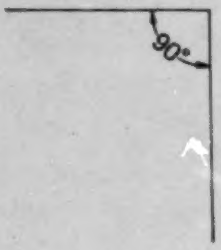
INFORMATION SHEET

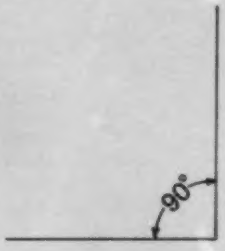
I. Terms and definitions

A. Geometric figures–Shapes formed by straight or curved lines

B. Right angle–Angle formed by two lines perpendicular to each other

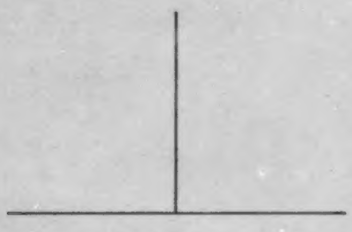
Examples:





C. Perpendicular–Line at right angle to another line or surface

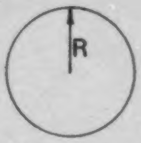
Example:



D. Parallel–Extending in the same direction; equal distance apart and never meeting

E. Radius–Line from center of a circle to any point on the circle

Example:



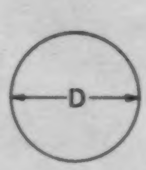
INFORMATION SHEET

F. Pi (π)--Greek letter used to represent the number by which the diameter of a circle is multiplied to get the circumference

(NOTE: Use π to equal 3 1/7, 3.1416, or 3.14, depending on which is more convenient in any given example.)

G. Diameter--Distance between outer edges of circle through center point

Example:



H. Circumference--Distance around the outer edge of a circle

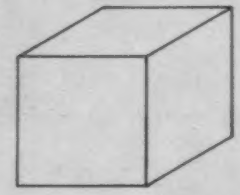
I. Area--Measure of the surface of a flat figure

J. Cut--Lowering the elevation of a grade

K. Fill--Raising the elevation of the ground

L. Cubic unit--Unit for measuring volume of an object containing length, width, and height

Example:



II. Types of geometric figures

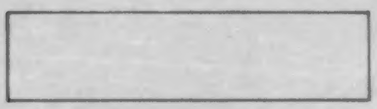
A. Square--Figure having four sides of equal length and four right angles

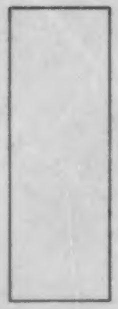
Example:

INFORMATION SHEET

B. Rectangle–Figure with two parallel ends of equal length, two parallel sides of equal length, and four right angles

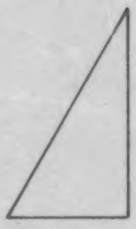
Examples:





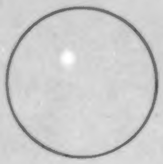
C. Triangle--Figure having three sides and three angles

Examples:



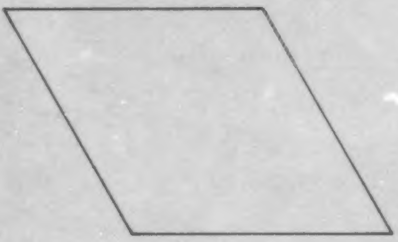
D. Circle–Flat, round figure formed by one curved line; all points of the curved line are of equal distance from the center point

Examples:



E. Rhombus–Figure having four sides of equal length and no right angles

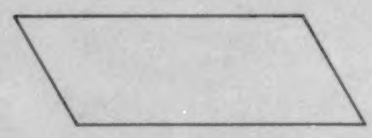
Example:



INFORMATION SHEET

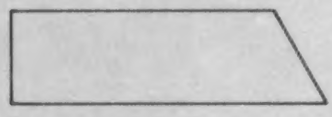
F. Parallelogram--Figure with two parallel ends of equal length, two parallel sides of equal length, and no right angles

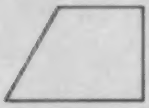
Example:



G. Trapezoid--Figure with only one pair of parallel opposite sides

Examples:





III. Units of measure

A. Inch (")--Equal to 1/12' (one-twelfth of a foot) or 1/36 yard (one-thirty-sixth of a yard)

B. Foot (')--Equal to 12" (twelve inches) or 1/3 yard (one-third of a yard)

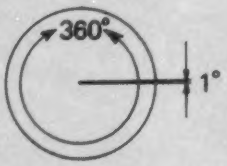
C. Yard--Equal to 3' (three feet) or 36" (thirty-six inches)

D. Rod--Equal to 16 1/2' (sixteen and one-half feet)

E. Mile--Distance equal to 5280' (five thousand two hundred and eighty feet)

F. Degree--Unit of measure for angles

Example:



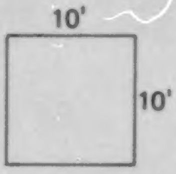
INFORMATION SHEET

IV. Formulas for calculating areas of geometric figures (Assignment Sheets #1-#6)

(NOTE: Area is always labeled in square units of measure.)

A. Square

Area = Length x Width or A = LW



Example: A = LW

L = 10'

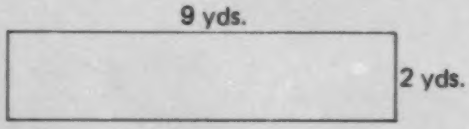
W = 10'

A = 10' x 10'

A = 100 square feet

B. Rectangle

Area = Length x Width or A = LW



Example: A = LW

L = 9 yds

W = 2 yds

A = 9 x 2

A = 18 square yards

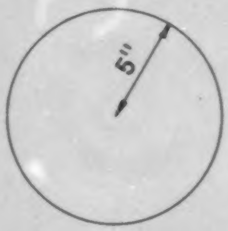
C. Circle

(NOTE: $\pi = 3.14$ or $\frac{c\ (\text{circumference})}{d\ (\text{diameter})}$)

Area = $\pi \times r^2$ (radius x radius)

$\pi = 3.14$

$A = \pi r^2$



Example: $A = \pi r^2$

r = 5"

A = 3.14 x (5 x 5)

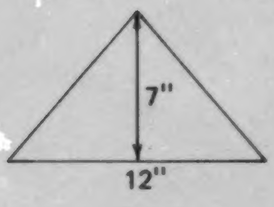
A = 78.50 square inches

INFORMATION SHEET

D. Triangle

Area = $\frac{1}{2}$ Base x Height

$A = \frac{1}{2} BH$



Example: $A = \frac{1}{2} BH$

B = 12"

H = 7"

A = ($\frac{1}{2}$ x 12") x 7"

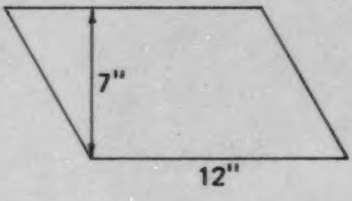
A = 6" x 7"

A = 42 square inches

E. Parallelogram

Area = Base x Height or A = BH

Example: A = BH



B = 12"

H = 7"

A = 12" x 7"

A = 84 square inches

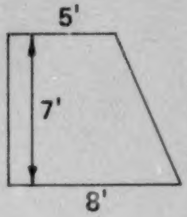
INFORMATION SHEET

F. Trapezoid

Area = $\frac{1}{2}$ Height x (Length of one base + length of other base)

$$A = \frac{1}{2} H (B_1 + B_2)$$

Example: $A = \frac{1}{2} H (B_1 + B_2)$



$H = 7'$

$B_1 = 8'$

$B_2 = 5'$

$A = \frac{1}{2} \times 7 \times (8 + 5)$

$A = \frac{7}{2} \times 13$

$A = \frac{7}{2} \times \frac{13}{1}$

$A = \frac{91}{2}$ or $45\frac{1}{2}$ square feet

V. Calculating volume of solid figures (Assignment Sheets #7-#10)

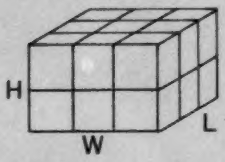
(NOTE: Volume is always labeled in cubic units of measure.)

A. Counting

Cubic Units = Number of cubes in layer x Number of layers

Example: 9 cubes x 2 layers = 18 cubic units

1. Top layer = 9 cubes
2. There are 2 layers
3. There are 18 cubes in this solid figure



INFORMATION SHEET

B. Formula

Volume = Length x Width x Height or V = LWH

Examples:

1. $V = LWH$

$L = 3'$

$W = \frac{1'}{2}$

$H = 1\frac{1'}{2}$

$V = 3 \times \frac{1}{2} \times \frac{3}{2}$

$V = \frac{9}{4}$ or $2\frac{1}{4}$ cubic feet

2. $V = LWH$

$L = 10'$

$W = 8'$

$H = 3'$

$V = 10 \times 8 \times 3$

$V = 240$ cubic feet

C. Estimating cubic yards

$$\frac{\text{Width in Feet x Length in Feet x Thickness in Feet}}{27} = \text{Cubic Yards}$$

(NOTE: The formula for calculating cubic yards is different because given measurements are usually in feet and inches. Thickness in inches has to be broken down by using fractions or decimals.)

Examples:

1. Fractions

$$\frac{30' \times 60' \times 4''}{27} = \frac{30' \times 60' \times 1/3'}{27} = 22.22 \text{ cubic yards}$$

2. Decimals

$$\frac{30' \times 60' \times .33'}{27} = \frac{594}{27} = 22 \text{ cubic yards}$$

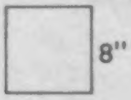
PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #1--CALCULATE AREA OF SQUARES

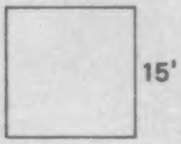
NAME________________________ SCORE __________

Calculate the area for each square below.

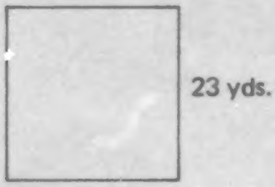
1. A = ________________________



2. A = ________________________



3. A = ________________________



4. $s = 10\frac{1}{2}$ miles

   A = ________________________

ASSIGNMENT SHEET #1

5. $s = 6\frac{1}{3}$ feet

A = ______________________________

6. $s = 8.7$ yards

A = ______________________________

7. $s = 1.42$ inches

A = ______________________________

8. $s = 9\frac{2}{3}$ inches

A = ______________________________

9. $s = 14.8$ feet

A = ______________________________

10. $s = \frac{1}{8}$ mile

A = ______________________________

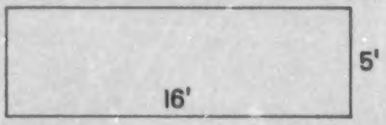
PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #2--CALCULATE AREA OF RECTANGLES

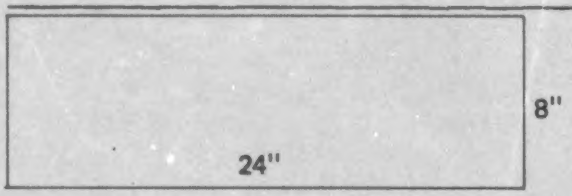
NAME ____________________ SCORE __________

Calculate the area for each rectangle below.

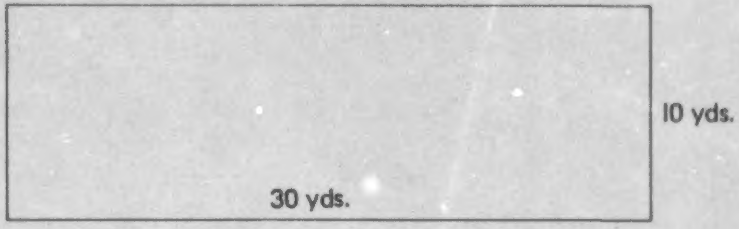
1. A = ____________________



2. A = ____________________



3. A = ____________________


10 yds.
30 yds.

4. L = 8"; W = $8\frac{1}{2}$"

A = ____________________

ASSIGNMENT SHEET #2

5. $L = 10\frac{1}{4}'$; $W = 8\frac{1}{2}'$

A = ______________________________

6. L = 4.6 yards; W = 8.4 yards

A = ______________________________

7. $L = 10\frac{1}{2}'$; $W = 8\frac{1}{4}'$

A = ______________________________

8. L = 4.75'; W = 3.1'

A = ______________________________

9. L = 12.2"; W = 0.8"

A = ______________________________

10. What is the area of a shopping center 1.5 miles long and 1.2 miles wide?

A = ______________________________

PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #3--CALCULATE AREA OF CIRCLES

NAME ________________________________ SCORE ____________

1. Calculate area of circles. Solve for the areas of the following circles. (Use $\pi = 3.14$.)

   a. Radius = 6 inches

   A = ______________________________

   b. Diameter = 10 feet

   A = ______________________________

   c. Diameter = 14 feet

   A = ______________________________

   d. Radius = 2.5 inches

   A = ______________________________

   e. Radius = 8 feet

   A = ______________________________

   f. Diameter = 11 inches

   A = ______________________________

ASSIGNMENT SHEET #3

g. Diameter = 7 feet

A = ________________________________

h. Radius = 3 inches

A = ________________________________

i. Radius = 10 yards

A = ________________________________

j. Diameter = 13 feet

A = ________________________________

2. Solve these word problems.

a. Find the area of a pit that has a diameter of 10 feet.

A = ________________________________

b. The radius of a circular driveway is 20 feet. Find the area.

A = ________________________________

c. The radius of a gear is 5 inches. What is the area of the gear?

A = ________________________________

ASSIGNMENT SHEET #3

d. The diameter of a clutch plate is 16 inches. What is the area of the clutch plate?

A = ______________________________

e. A circular walk 2 feet wide is laid around a boulder 10 feet in diameter. What is the area of the walk? (Find the area of a boulder 14 feet in diameter and subtract the area of a boulder 10 feet in diameter.)

A = ______________________________

f. The diameter of tractor wheel measures 36 inches. What is the area of the wheel?

A = ______________________________

g. Find the area over which a dozer will run if it can travel only in a 15 foot radius.

A = ______________________________

h. An oil drum is 5 feet in diameter. Find the area.

A = ______________________________

i. Find the area of a pond whose radius is 8 feet.

A = ______________________________

j. If the operating radius of a crane is 45 feet, what would be the area of the complete circle the crane is operating in?

A = ______________________________

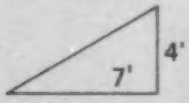
PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #4--CALCULATE AREA OF TRIANGLES

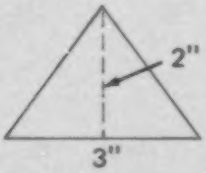
NAME______________________________ SCORE __________

Calculate the area for each triangle below.

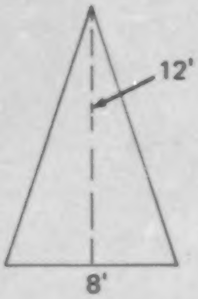
1. A = ______________________________



2. A = ______________________________



3. A = ______________________________



4. b = 12", h = $8\frac{1}{2}''$

   A = ______________________________

ASSIGNMENT SHEET #4

5. b = 3.2', h = 5.8'

A = ____

6. What is the area of a triangular parking lot that is 1.01 miles across (base) and 0.05 miles long (height)?

A = ____

7. b = 0.8", h = 0.2"

A = ____

8. b = $1\frac{1}{7}$ yards, h = $5\frac{1}{3}$ yards

A = ____

9. b = $9\frac{1}{2}$"; h = $10\frac{1}{4}$"

A = ____

10. How many square feet of dirt are in an area with a base of 18 yards and a height of 3 yards?

A = ____

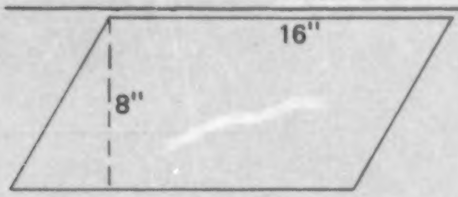
PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #5--CALCULATE AREA OF PARALLELOGRAMS

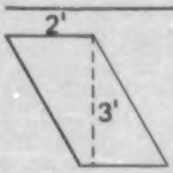
NAME____ SCORE ____________

Calculate the area for each parallelogram below.

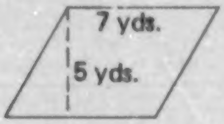
1. A = ____



2. A = ____



3. A = ____



4. How many square miles are in an area that is 4 1/2 miles long (base) and 5 1/3 miles across (height)?

   A = ____

5. b = 1.7', h = 4.2'

   A = ____

ASSIGNMENT SHEET #5

6. $b = 8", h = 2\frac{1}{2}"$

A = ______________________________

7. What is the area of a swimming pool that is 106 feet long (base) and 12 feet across (height)?

A = ______________________________

8. $b = 10\frac{1}{3}"; h = 1\frac{1}{5}"$

A = ______________________________

9. $b = 13\frac{1}{6}'; h = 12'$

A = ______________________________

10. b. = 12.3 yards, h = 1.1 yards

A = ______________________________

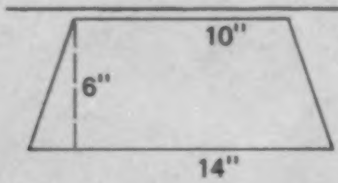
PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #6--CALCULATE AREA OF TRAPEZOIDS

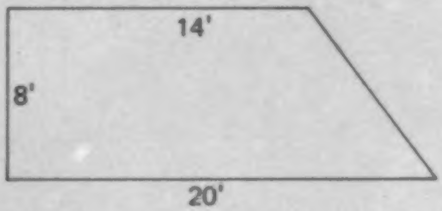
NAME ______________________________ SCORE ______________

Calculate the area for each trapezoid below.

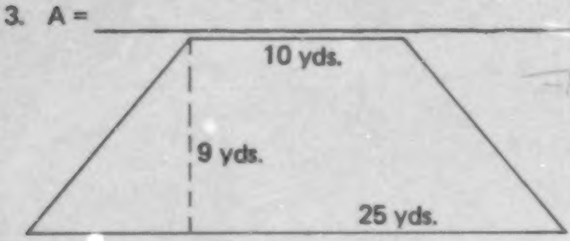
1. A = ______________________________



2. A = ______________________________



3. A = ______________________________


10 yds.
9 yds.
25 yds.

4. h = 4", b_1 = 7", b_2 = 2"

A = ______________________________

5. h = 8.2 yards, b_1 = 1.3 yards, b_2 = 0.5 yards

A = ______________________________

ASSIGNMENT SHEET #6

6. $h = 3\frac{1}{2}'$; $b_1 = 3\frac{1}{4}'$; $b_2 = 2\frac{3}{4}'$

A = ________________________________

7. How many square miles are in a development that is 12 miles across (height) and has sides (bases) of 5 1/2 miles and 7 1/2 miles?

A = ________________________________

8. What is the total area of a lot 13 rods across (height) and sides (bases) of 6 rods and 4 rods?

A = ________________________________

9. $h = 0.04'$; $b_1 = 1.7'$; $b_2 = 2.3'$

A = ________________________________

10. $h = 1.8''$; $b_1 = 0.5''$; $b_2 = 8.5''$

A = ________________________________

PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #7--COUNT CUBIC UNITS TO DETERMINE VOLUME

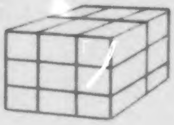
NAME ______________________________ SCORE ____________

Record the dimensions and volume for the figures below this chart.

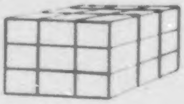
(NOTE: Volume is the number of cubic units.)

	height = H	width = W	length = L	volume = V
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

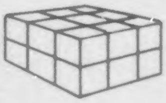
1.



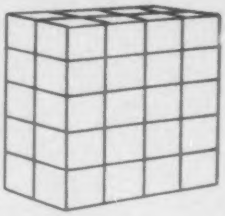
2.



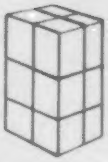
3.



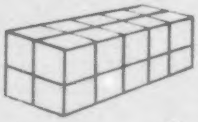
4.



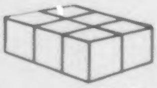
5.



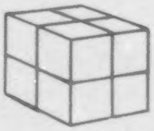
6.



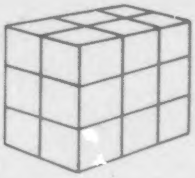
7.



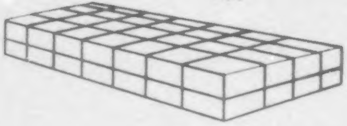
8.



9.



10.



PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #8--DETERMINE CUBIC INCHES AND CUBIC FEET

NAME______________________________ SCORE ____________

1. Answer these questions about the figure below.

   a. How many cubes are in the box?____________________

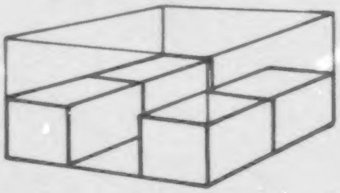
   b. How many cubes are needed to complete the bottom layer?____________

   c. How many layers can the box hold inside?____________________

   d. How many cubes are needed for the top layer?____________________

   e. How many cubes would there be if the box were full?____________

   f. What is the volume of the box?____________________



2. Answer these questions about the figure below.

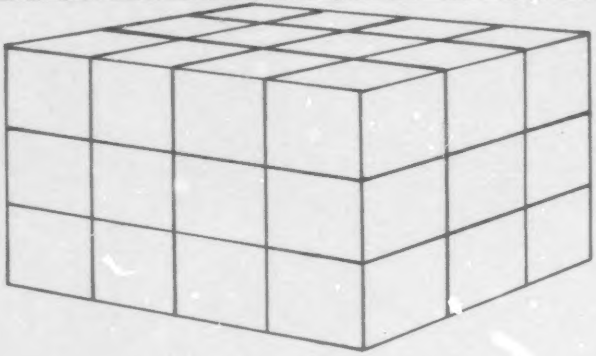
   a. How many cubes are in the bottom layer?____________________

   b. How many layers are there?____________________

   c. What is the way to figure the volume *without counting* all the cubes one by one?

   ____

   ____



ASSIGNMENT SHEET #8

3. Answer these questions about the figure below.

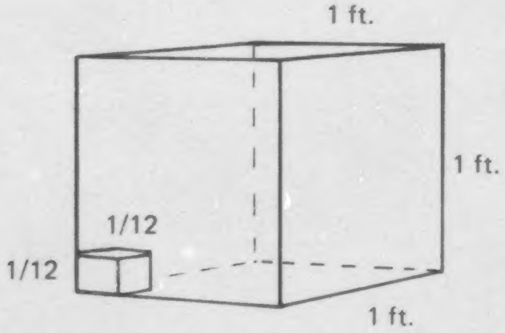
   a. How many cubic inches in 1 cubic foot? (Think of stacking cubic inches in a cubic foot box.) ______

   b. How many cubic inches would it take to fill one layer? ______

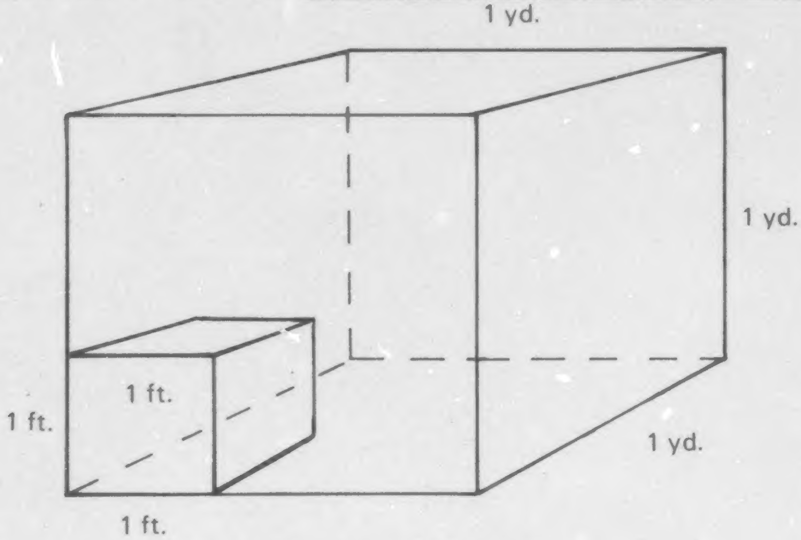
   c. How many cubic inches would it take to fill two layers? ______

   d. How many cubic inches would it take to fill three layers? ______

   e. How many layers would it take to fill the box? ______



4. How many cubic feet in 1 cubic yard? ______



ASSIGNMENT SHEET #8

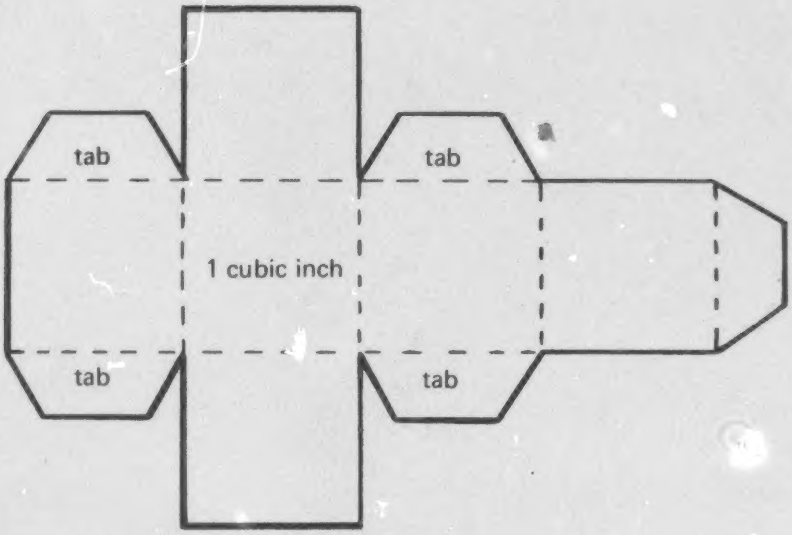
5. Make a cubic inch.

   a. Copy pattern on cardboard

   b. Cut out

   c. Fold on dotted lines

   d. Glue tabs to form a cube

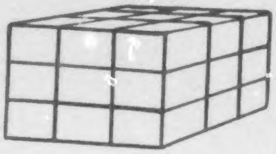


6. Get together with your classmates and collect all your cubic inches to complete this exercise.

   a. Let the cubes represent cubic feet

   b. Make a pile of cubic feet forming a cubic yard as shown in this figure

   c. Rearrange the cubic feet blocks to make other figures filling one cubic yard of space



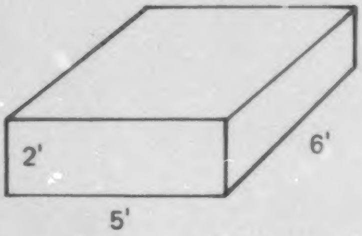
PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #9--CALCULATE VOLUME USING A FORMULA

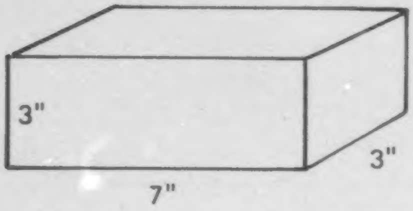
NAME____ SCORE ____________

Use the formula V = LWH to calculate these volumes.

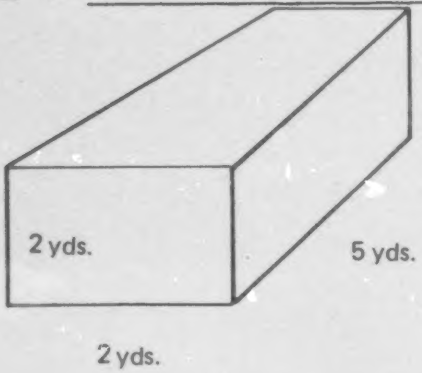
1. V = ______________________________



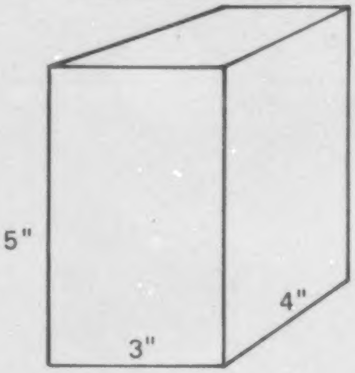
2. V = ______________________________



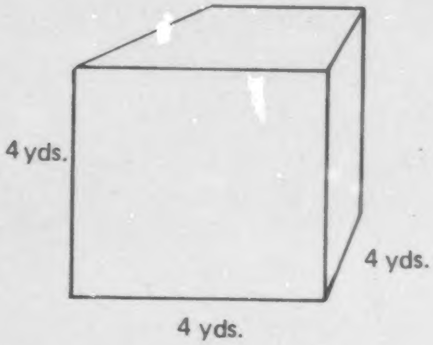
3. V = ______________________________


2 yds.
5 yds.
2 yds.

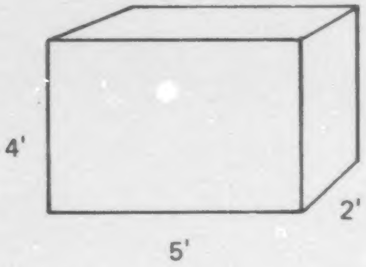
4. V = ______________________________



5. V = ______________________________

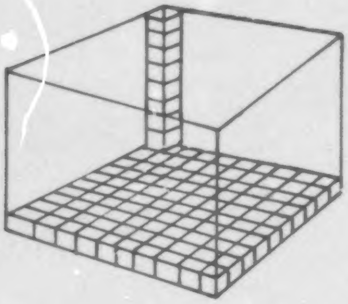

4 yds.
4 yds.
4 yds.

6. V = ______________________________

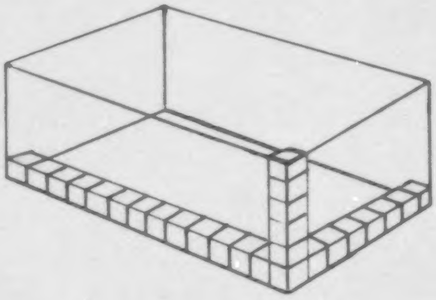


ASSIGNMENT SHEET #9

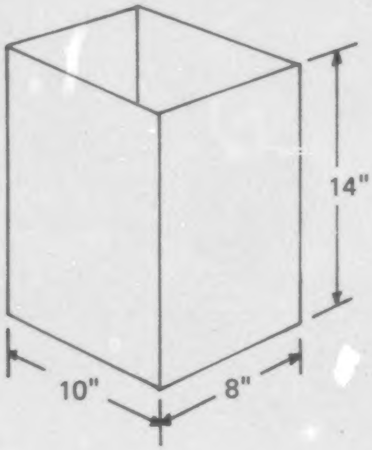
7. V = ____________________



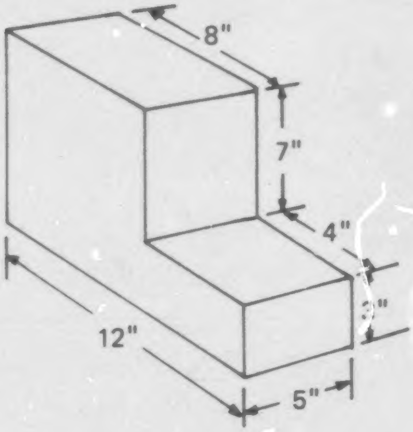
8. V = ____________________



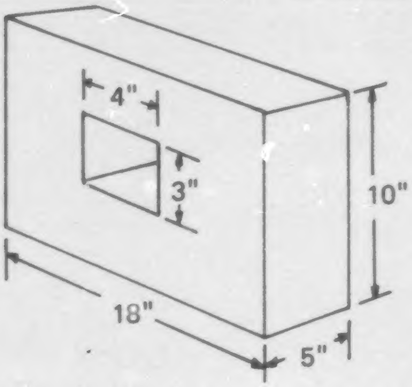
9. V = ____________________



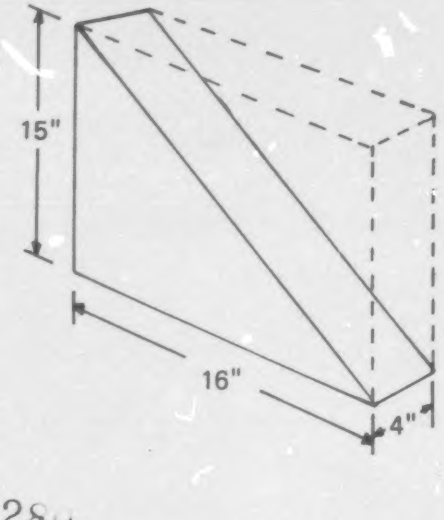
10. V = ____________________



11. V = ____________________



12. V = ____________________



PRACTICAL MATH
UNIT II

ASSIGNMENT SHEET #10--ESTIMATE CUBIC YARDS

NAME ________________________________ SCORE ____________

Solve the following problems involving cubic yards.

1. How many cubic yards of fill will it take to fill the floor of a swimming pool 22' wide by 42' long by 8" thick? ______________________

2. How much soil will have to be cut from a parking lot 120' long by 64' wide and 4" thick? ______________________

3. How much gravel will it take to fill a ditch 3' wide by 3' deep by 102' long?

   ____

4. Find the total cubic yards it will take to pour a concrete dam that is 12' high, 4' thick at the top, 8' thick at the bottom, and 44' long. ______________________

5. Find the total amount of fill it would take to fill an excavation 86' long and 38' wide if 4" of sand, 6" of #12 gravel, and 3" of #6 gravel were needed.

   ____

PRACTICAL MATH
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 64 square inches
2. 225 square feet
3. 529 square yards
4. $110\frac{1}{4}$ square miles
5. $40\frac{1}{4}$ square feet
6. 75.69 square yards
7. 2.0164 square inches
8. $93\frac{4}{9}$ square inches
9. 219.04 square feet
10. 62.41 square miles

Assignment Sheet #2

1. 80 square feet
2. 192 square inches
3. 300 square yards
4. 20 square inches
5. $87\frac{1}{8}$ square feet
6. 38.64 square yards
7. $86\frac{5}{8}$ square inches
8. 14.725 square feet
9. 9.76 square inches
10. 1.8 square miles

Assignment Sheet #3

1. a. 113.04 square inches
   - b. 78.5 square feet
   - c. 153.86 square feet
   - d. 19.625 square inches
   - e. 200.96 square feet
   - f. 94.985 square inches
   - g. 38.465 square feet
   - h. 28.26 square inches
   - i. 314 square yards
   - j. 132.665 square feet
2. a. 78.5 square feet
   - b. 1256 square feet
   - c. 78.5 square inches
   - d. 200.96 square inches
   - e. 75.36 square feet
   - f. 1017.36 square inches
   - g. 706.5 square feet
   - h. 19.625 square feet
   - i. 200.96 square feet
   - j. 6358.50 square feet

Assignment Sheet #4

1. 14 square feet
2. 3 square inches
3. 48 square feet
4. 51 square inches
5. 9.28 square feet
6. 0.02525 square miles
7. 0.08 square inches
8. $3\frac{1}{21}$ square yards
9. 48.68 square inches
10. 27 square yards

Assignment Sheet #5

1. 128 square inches
2. 6 square feet
3. 35 square yards
4. 24 square miles
5. 7.14 square feet
6. 20 square inches
7. 1272 square feet
8. $12\frac{2}{5}$ square inches
9. 158 square feet
10. 13.53 square yards

Assignment Sheet #6

1. 72 square inches
2. 136 square feet
3. $157\frac{1}{2}$ square yards
4. 18 square inches
5. 7.38 square yards
6. $10\frac{1}{2}$ square feet
7. 78 square miles
8. 65 square rods
9. 0.08 square feet
10. 8.1 square inches

Assignment Sheet #7

	H	W	L	V
1.	3	3	2	18
2.	3	3	3	27
3.	2	3	3	18
4.	5	2	4	40
5.	3	2	2	12
6.	2	2	5	20
7.	1	2	3	6
8.	2	2	2	8
9.	3	2	3	18
10.	2	4	7	56

(NOTE: Answers may be reversed in the width and length columns.)

Assignment Sheet #8

1. a. 4 cubes
   b. 2 cubes
   c. 2 layers
   d. 6 cubes
   e. 12 cubes
   f. 12 units

2. a. 12 cubes
   b. 3 layers
   c. Answers may vary (evaluated to satisfaction of the instructor)

3. a. 1728 cubic inches
   b. 144 cubic inches
   c. 288 cubic inches
   d. 432 cubic inches
   e. 12 layers

4. 27 cubic feet
5. Teacher evaluation
6. Teacher evaluation

Assignment Sheet #9

1. 60 cubic feet
2. 63 cubic inches
3. 20 cubic yards
4. 60 cubic inches
5. 64 cubic yards
6. 40 cubic feet
7. 900 cubic units
8. 672 cubic units
9. 1120 cubic inches
10. 460 cubic inches
11. 840 cubic inches
12. 480 cubic inches

Assignment Sheet #10

1. 22.58 cubic yards
2. 93.86 cubic yards
3. 34 cubic yards
4. 117.33 cubic yards
5. 130.44 cubic yards

PRACTICAL MATH
UNIT II

TEST

NAME______________________________ SCORE ____________

1. Match terms associated with practical math to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Lowering the elevation of a grade

_____b. Greek letter used to represent the number by which the diameter of a circle is multiplied to get the circumference

_____c. Extending in the same direction; equal distance apart and never meeting

_____d. Shapes formed by straight or curved lines

_____e. Unit for measuring volume of an object containing length, width, and height

_____f. Measure of the surface of a flat figure

_____g. Distance between outer edges of circle through center point

_____h. Raising the elevation of the ground

_____i. Line from center of a circle to any point on the circle

_____j. Angle formed by two lines perpendicular to each other

_____k. Distance around the outer edge of a circle

_____l. Line at right angle to another line or surface

1. Geometric figures
2. Right angle
3. Perpendicular
4. Parallel
5. Radius
6. Pi (π)
7. Diameter
8. Circumference
9. Area
10. Cut
11. Fill
12. Cubic unit

2. Match types of geometric figures to the correct descriptions. Write the correct numbers in the blanks provided.

_____a. Figure with only one pair of parallel opposite sides

_____b. Figure having three sides and three angles

_____c. Figure with two parallel ends of equal length, two parallel sides of equal length, and four right angles

_____d. Figure having four sides of equal length and no right angles

_____e. Figure having four sides of equal length and four right angles

_____f. Figure with two parallel ends of equal length, two parallel sides of equal length, and no right angles

_____g. Flat, round figure formed by one curved line; all points of the curved line are of equal distance from the center point

1. Square
2. Rectangle
3. Triangle
4. Circle
5. Rhombus
6. Parallelogram
7. Trapezoid

3. Match units of measure to correct definitions. Write the correct numbers in the blanks provided.

_____a. Equal to 16 1/2' (sixteen and one-half feet)

_____b. Equal to 12" (twelve inches) or 1/3 yard (one-third of a yard)

_____c. Unit of measure for angles

_____d. Equal to 1/12' (one-twelfth of a foot) or 1/36 yard (one-thirty-sixth of a yard)

_____e. Equal to 3' (three feet) or 36" (thirty-six inches)

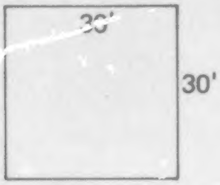
_____f. Distance equal to 5280' (five thousand two hundred and eighty feet)

1. Inch (")
2. Foot (')
3. Yard
4. Rod
5. Mile
6. Degree

4. Calculate area of each of the following geometric figures.

a. Square

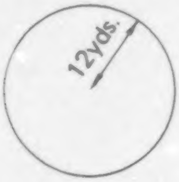
A = ______________________________



b. Circle

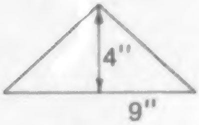
(NOTE: Use $\pi = 3.14$.)

A = ______________________________



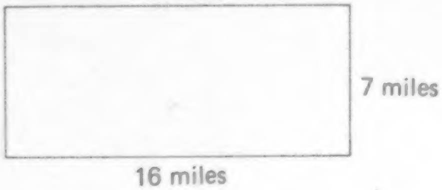
c. Triangle

A = ______________________________



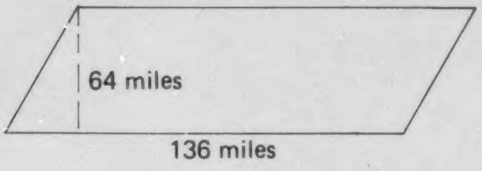
d. Rectangle

A = ______________________________


7 miles
16 miles

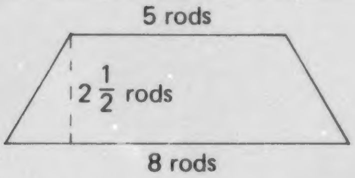
e. Parallelogram

A = ______________________________


64 miles
136 miles

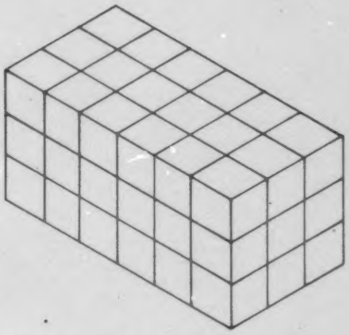
f. Trapezoid

A = ______________________________

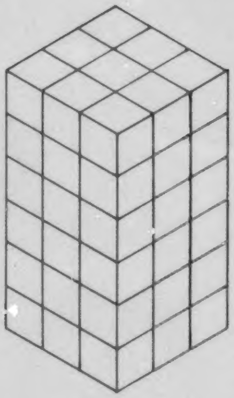

5 rods
$2\frac{1}{2}$ rods
8 rods

5. Calculate the volume of the following solid figures. Write the correct answers in the blanks provided.

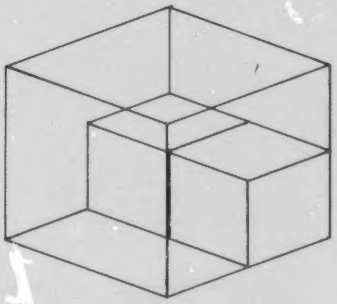
a. Counting



1) V= ____________________



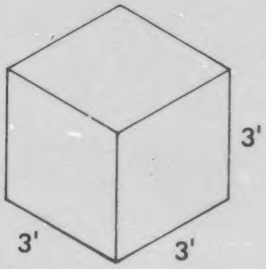
2) V = ____________________



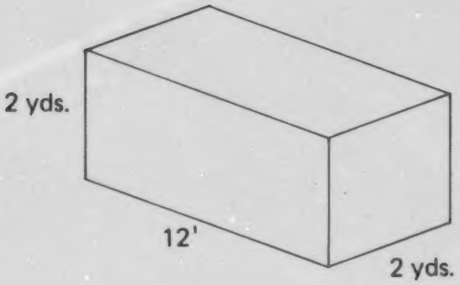
3) How many more cubes are needed to fill the box?

V = _______________

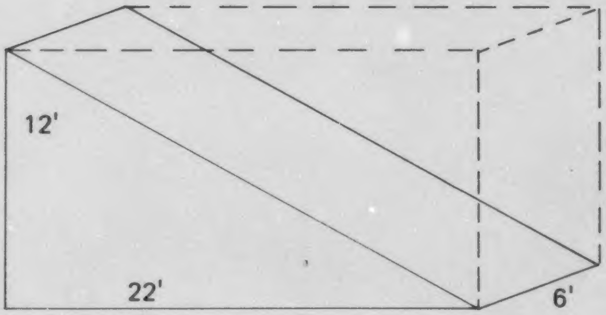
b. Formula



1) V = _______________


2 yds.
12'
2 yds.

2) V=____________________________



3) V=____________________________

4) How much fill will it take to fill an area 42' long by 36' wide by 6" high?

V = ____________________________

5) How much sand will it take to fill the bed of a truck 3' deep by 8 1/2' wide by 12' long?

V = ____________________________

6) What would be the volume of a bucket 24" high, 72" long, and 36" wide?

V = ______________________________

c. Calculate the number of cubic yards for a cut 12' wide by 144' long by 12" high.

V = ______________________________

PRACTICAL MATH
UNIT II

ANSWERS TO TEST

1. a. 10
   b. 6
   c. 4
   d. 1
   e. 12
   f. 9
   g. 7
   h. 11
   i. 5
   j. 2
   k. 8
   l. 3
2. a. 7
   b. 3
   c. 2
   d. 5
   e. 1
   f. 6
   g. 4
3. a. 4
   b. 2
   c. 6
   d. 1
   e. 3
   f. 5
4. a. 900 square feet
   b. 452.16 square yards
   c. 18 square inches
   d. 112 square miles
   e. 8704 square miles
   f. $16\frac{1}{4}$ square rods
5. a. Counting
   1) 54 cubic units
   2) 54 cubic units
   3) 6 cubic units

b. Formula

1) 27 cubic feet or 1 cubic yard

2) 16 cubic yards

3) 792 cubic feet

4) 112 cubic yards

5) $11\frac{1}{3}$ cubic yards

6) 62,208 cubic inches or 432 cubic feet or 16 cubic yards

c. Calculating cubic yards--64 cubic yards

GRADE WORK
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to interpret the uses of stakes and information found on stakes. The student should also be able to identify layout stakes. This knowledge will be evidenced by completion of assignment sheets, job sheets, and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with grade work to the correct definitions.
2. Select from a list the purposes of stakes.
3. Name information given on stakes.
4. Match types of stakes to the correct uses.
5. Describe the importance of stakes.
6. Distinguish between full station and plus station.
7. Identify equipment used by the operator to check stakes.
8. Label parts of the hand level.
9. Select from a list reasons for using slope stakes.
10. State the meaning of slope ratio.
11. Label parts of a roadbed.
12. Select from a list features of a good road design.
13. Arrange in order procedures for laying in a roadbed.
14. Distinguish between backslope and foreslope.
15. Read an engineer's rule.
16. Demonstrate the ability to:
    a. Check a cut and fill.
    b. Check grades (transfer elevations).
    c. Transfer elevations.
    d. Use a hand level to find height of a hill

GRADE WORK
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide students with objective sheet.

  B. Provide students with information, assignment, and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss the procedures outlined in job sheets.

  G. Provide different types of leveling jobs for students.

  H. Give test.

II. Instructional materials:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Offset Stakes

    2. TM 2--Slope Stakes

    3. TM 3--Read the Rule and Rod

  D. Assignment Sheet #1--Read an Engineer's Rule

  E. Answers to assignment sheet

  F. Job sheets

    1. Job Sheet #1--Check a Cut and Fill

    2. Job Sheet #2--Check Grades (Transfer Elevations)

    3. Job Sheet #3--Transfer Elevations

    4. Job Sheet #4--Use a Hand Level to Find Height of a Hill

  G. Test

  H. Answers to test

III. Unit references:

A. Nichols, Herbert L., Jr. *Moving the Earth*. 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.

B. Hendrix, Laborn J. "Bud." *Millwright Instructional Materials*. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

IV. Filmstrips:

A. *Use of the Level: Setting Up the Instrument*. Color, 43 frames, Vocational Education Productions, n.d. Available from Vocational Education Productions, California State Polytechnic University, San Luis Obispo, California 93407.

B. *Use of the Level: Reading the Rod*. Color, 39 frames, Vocational Education Productions, n.d. Available from Vocational Education Productions, California State Polytechnic University, San Luis Obispo, California 93407.

GRADE WORK
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Grade work--Plotting and correction of irregularities of the ground to a definite limit of grade and alignment

B. Crowfoot--Mark indicating the point of a certain grade

C. Keel--Crayon used in construction work

D. H.I.--Height of instrument; vertical distance from the bench mark to the line of sight of the instrument

E. Elevation--Given grade

F. Bench mark (BM)--Permanent point of known or assumed elevation

G. Line of sight--Line through the leveling instrument as viewed by the eye; point where vertical hair crosses the horizontal hair

H. TBM--Temporary bench mark

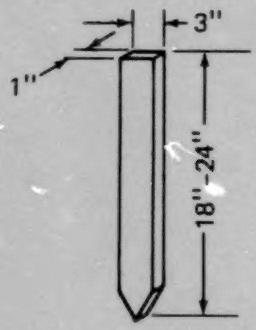
I. Slope--Ground that forms a natural or artificial incline upward or downward

J. Ratio--Proportion; relationship in quantity, amount, or size between two or more things

II. Purposes of stakes

(NOTE: Stakes are generally rectangular and approximately 1" thick by 3" wide and 18" to 24" long.)

Example:



INFORMATION SHEET

- A. Plot horizontal position
- B. Outline width
- C. Indicate grades
- D. Outline size
- E. Indicate center lines

III. Information given on stakes

- A. Type of stake
- B. Station number

  Example: (STA 1 + 00)
- C. Required grades

  Example: (⊼ or ⊻)

  (NOTE: These symbols are known as crowfeet.)
- D. Locations
- E. Boundaries

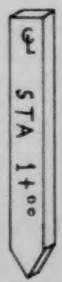
IV. Uses of types of stakes (Transparencies 1 and 2)

- A. Alignment--Mark horizontal position of work and outline direction and size of project

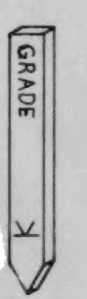
  (NOTE: Alignment stakes may also be station stakes and are set every 100 feet, except on curves and hills where they will be set closer.)
- B. Center line (℄)--Indicate center line of project and station number

  (NOTE: Most stakes are marked on both sides; on center line stakes the station number is on front and grade on back.)

  Examples:



Front

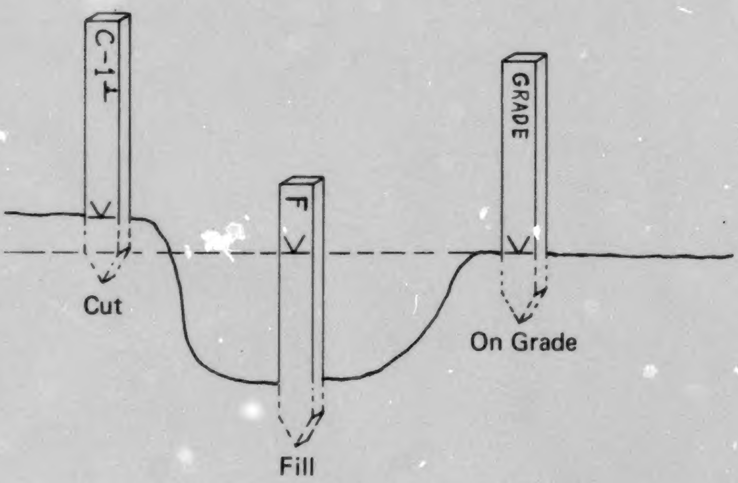


Back

INFORMATION SHEET

C. Grade (⊻ ⊼)--Indicate vertical dimensions of work

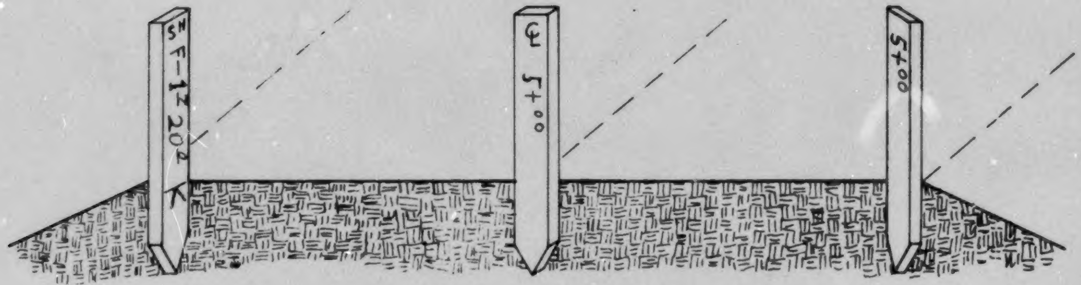
Examples:



D. Shoulder (SH)--Mark outer edge of shoulders; set with broad side facing center line of road on shoulder line

(NOTE: These stakes are set parallel in the same direction and interval with the center line stakes.)

Examples:



Front with Fill Grade and Horizontal Distance to Center Line

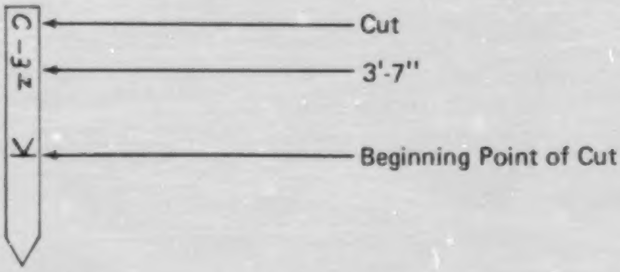
Center Line with Station

Back with Station

INFORMATION SHEET

E. Cut (C)--Indicate amount of earth to be cut to obtain desired grade

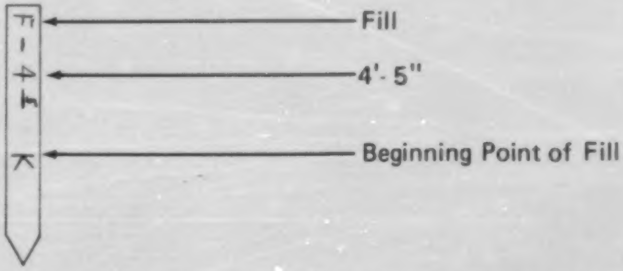
Example:


C-3 7
K
Cut
3'-7"
Beginning Point of Cut

F. Fill (F)--Indicate amount of material needed to bring existing ground to desired grade

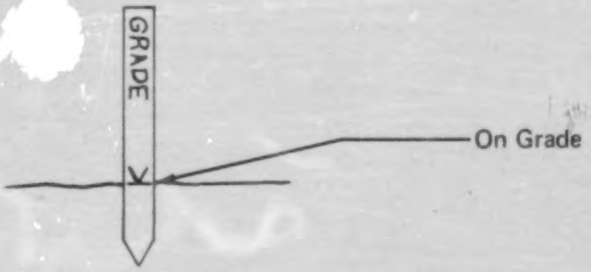
(NOTE: Grades are measured from the crowfoot mark on the stake.)

Example:


F-4 5
K
Fill
4'-5"
Beginning Point of Fill

G. On-grade (Grade or Grd)--Indicate desired grade; no fill or cut is necessary

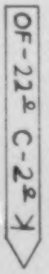
Example:


GRADE
K
On Grade

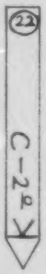
INFORMATION SHEET

H. Offset (OF or O)--Should be relocated away from area so that it will not be damaged or destroyed

Examples:



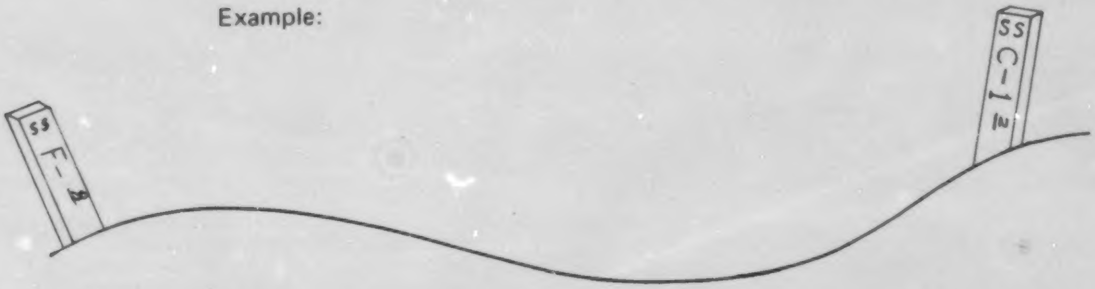
or



(NOTE: Figure below OF or inside the circle indicates the linear feet from offset stake to original reference stake. The difference in elevation must also be noted on the offset stake.)

I. Slope (SS)--Indicate intersection of the cut or fill of outer slopes with the existing natural ground line and the limit of earth work on each side of the center line

Example:

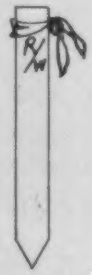


J. Right-of-way (R/W)--Identify boundaries of a project

(CAUTION: Do not operate equipment outside these boundaries.)

(NOTE: These stakes may be identified with the symbol R/W or by a colored cloth tied around the top.)

Example:

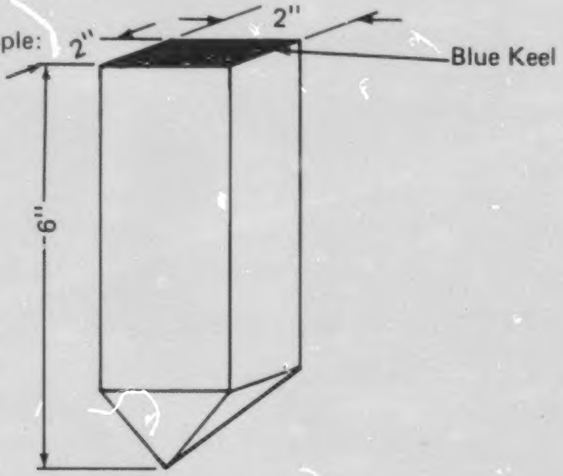


INFORMATION SHEET

K. Blue tops--Hub stakes used during the final grading process when the existing grade is within 0.2 feet of desired grade

(NOTE: These stakes are usually 2" x 2" x 6" and are driven into the ground so the top is at exact finish grade. The top is colored with blue keel to identify it.)

Example:



V. Importance of stakes

A. Purpose of stakes

B. Information found on stakes

(NOTE: Information found on stakes is the only thing the operator has to work from.)

C. Location of stakes

(NOTE: It is very important that stakes are not run over or disturbed in any way because this will create an error if not detected, and could require resetting and a delay in the job progress.)

VI. Types of stations

A. Full station--Located every 100 feet beyond starting station

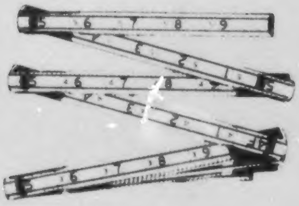
(NOTE: Starting station is numbered 0+^{00}; the next one is one hundred feet from the first and is numbered 1+^{00}, the next 2+^{00}, and so on.)

B. Plus station--Located a shorter distance from preceding station, such as on curves and rough ground, where it is necessary to set stakes closer together

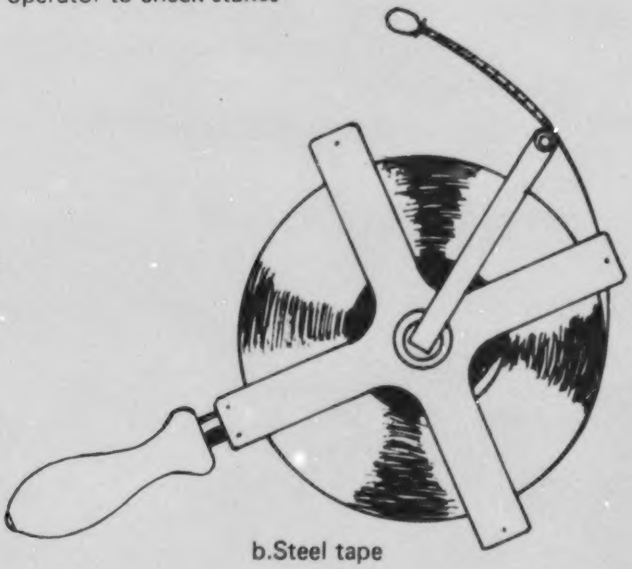
(NOTE: These stations are numbered as 5+^{50}, 5+^{65}, 5+^{85}, and so on.)

INFORMATION SHEET

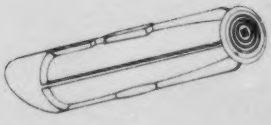
VII. Equipment used by the operator to check stakes



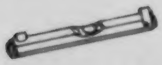
a. Engineer's rule



b. Steel tape

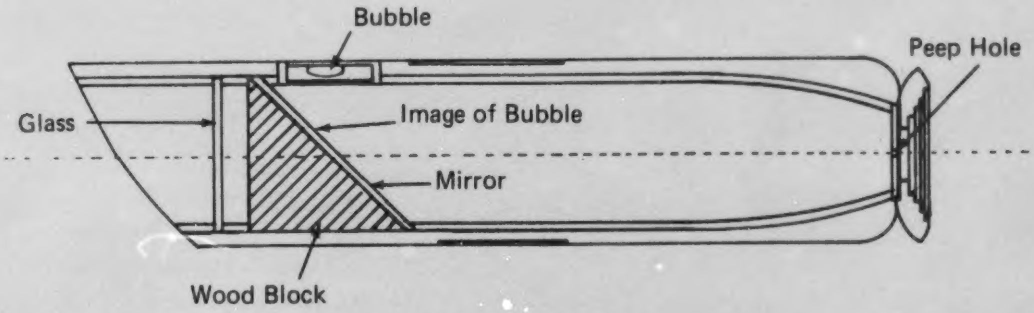


c. Hand level



d. String level

VIII. Parts of the hand level


Bubble
Peep Hole
Glass
Image of Bubble
Mirror
Wood Block

(CAUTION: All instruments are precision instruments, so extreme caution must be observed when working with them.)

INFORMATION SHEET

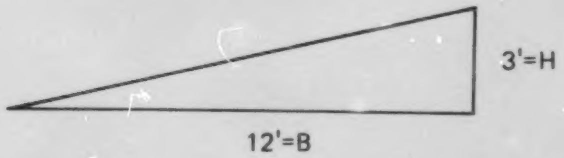
IX. Reasons for using slope stakes

- A. Provide first markers for work crew
- B. Show outer limits of area
- C. Show necessary cut or fill
- D. Show distance and direction of center line
- E. Show steepness of slope

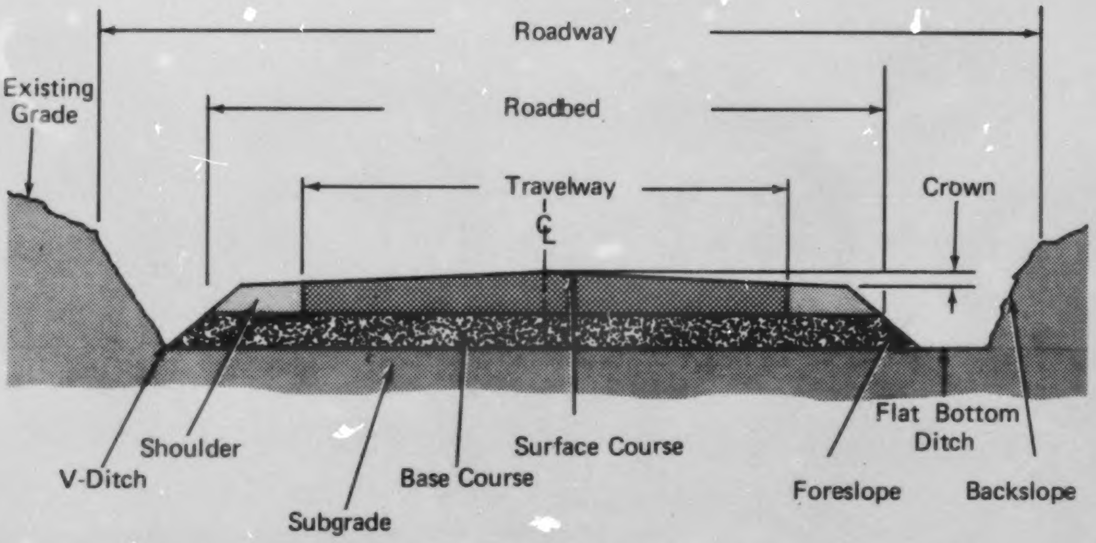
(NOTE: "Cut" slope stakes may slant slightly away from center line, and "fill" slope stakes may slant toward it.)

X. Slope ratio--Ratio of horizontal distance to vertical distance

Example: Base (12')÷Height (3') = 4 = (4 to 1)
4:1 = Slope ratio



XI. Parts of a roadbed


Roadway
Existing Grade
Roadbed
Travelway
℄
Crown
Shoulder
V-Ditch
Subgrade
Base Course
Surface Course
Flat Bottom Ditch
Foreslope
Backslope

INFORMATION SHEET

XII. Features of a good road design

- A. Drainage
- B. Crown
- C. Bridges and culverts
- D. Gradual grade
- E. Moderate curves
- F. Weather resistance
- G. Smooth and durable surface
- H. Super elevations

XIII. Procedures for laying in a roadbed

- A. Clearing and grubbing
- B. Stripping top soil
- C. Stockpiling
- D. Excavating subgrade
- E. Laying up base
- F. Establishing ditches
- G. Finishing surface course

XIV. Difference between backslope and foreslope

- A. Backslope--Extends from top of existing grade cut to bottom of ditch
- B. Foreslope--Extends from outside of shoulder to bottom of ditch

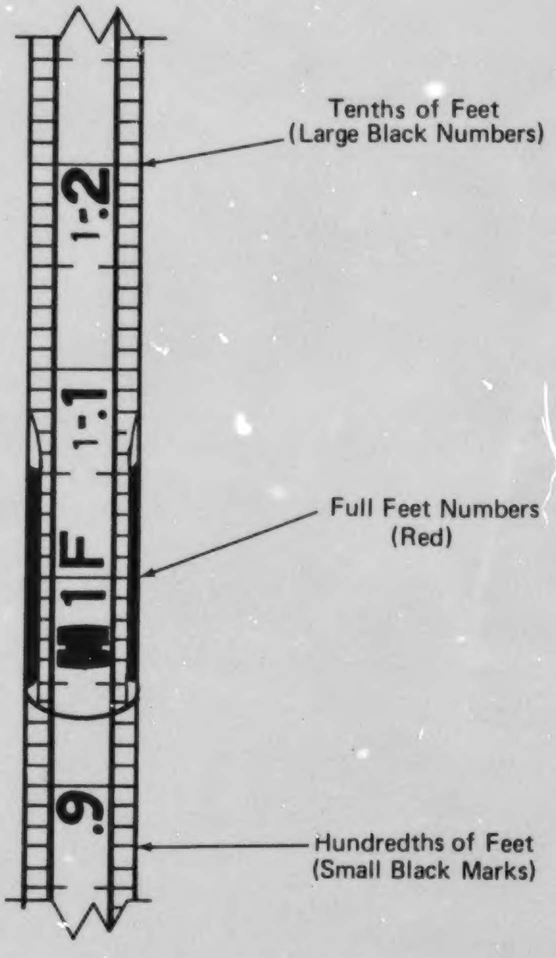
XV. Read an engineer's rule (Transparency 3; Assignment Sheet #1)

- A. Large red numbers = Full Feet
- B. Large black numbers at large black marks = Tenths of feet

INFORMATION SHEET

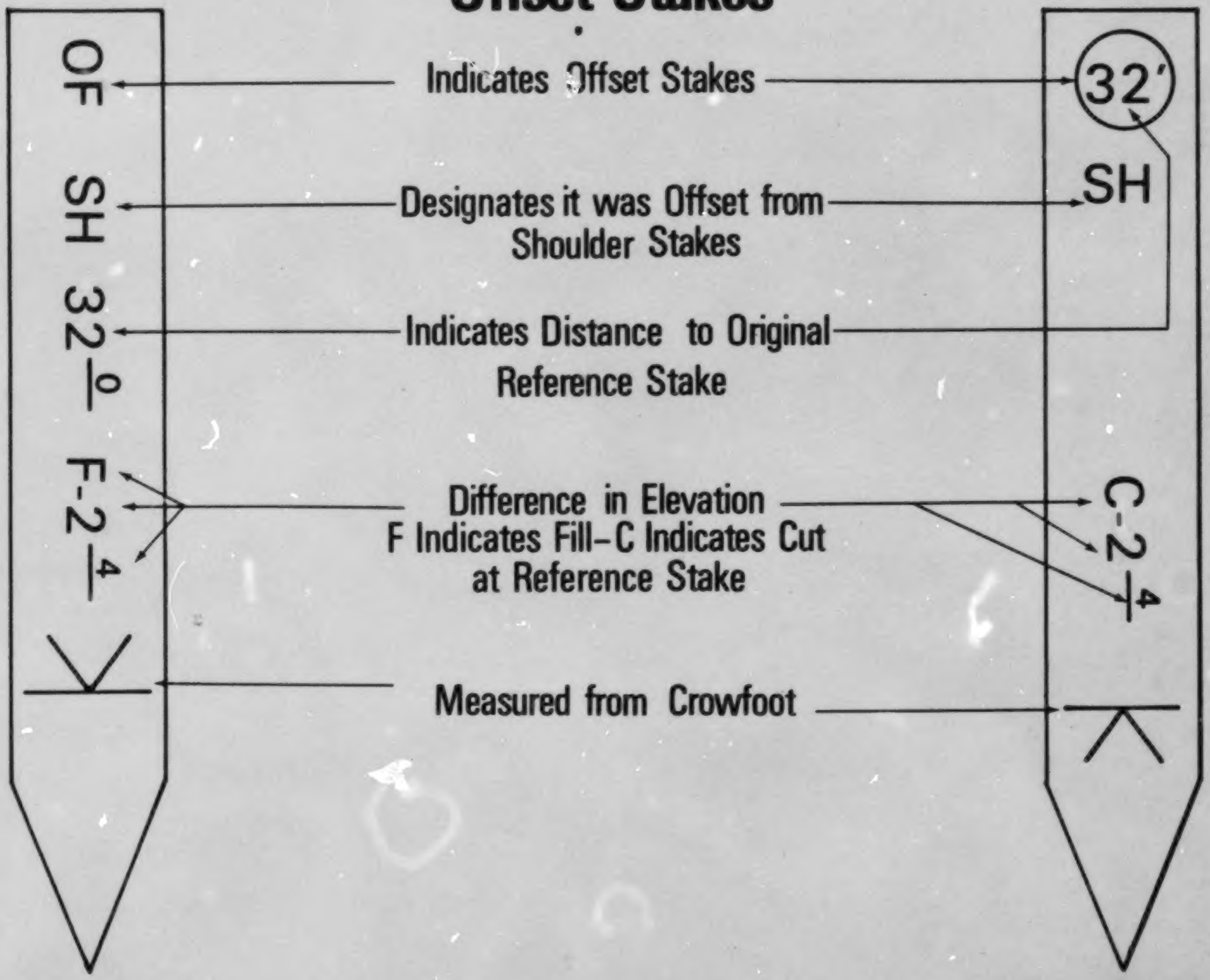
C. Small black marks = Hundredths of feet

Example:


Tenths of Feet
(Large Black Numbers)
1.2
1.1
1F
.9
Full Feet Numbers
(Red)
Hundredths of Feet
(Small Black Marks)

(NOTE: An engineer's rule and a positive reading rod are marked the same and read the same.)

Offset Stakes



Indicates Offset Stakes

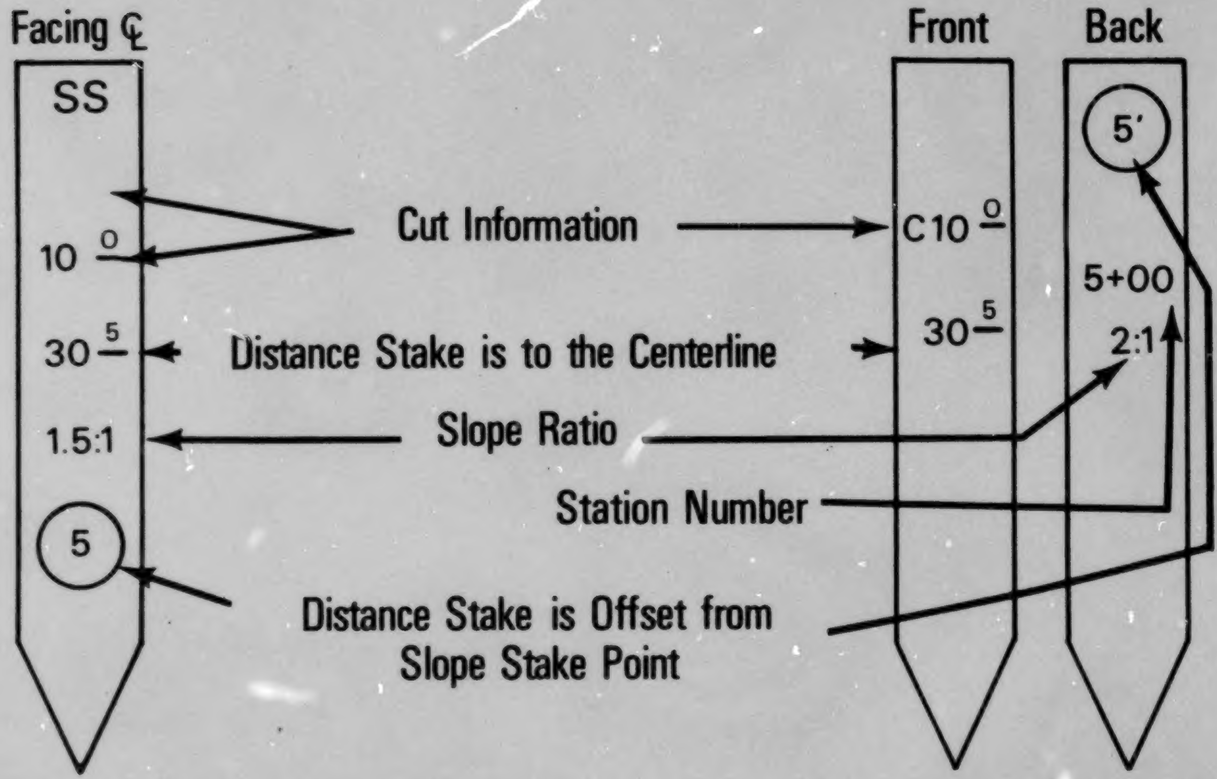
Designates it was Offset from Shoulder Stakes

Indicates Distance to Original Reference Stake

Difference in Elevation
F Indicates Fill–C Indicates Cut
at Reference Stake

Measured from Crowfoot

Slope Stakes


Facing ℄
SS
10 $\frac{0}{}$
30 $\frac{5}{}$
1.5:1
5
Front
C10 $\frac{0}{}$
30 $\frac{5}{}$
Back
5′
5+00
2:1

Cut Information

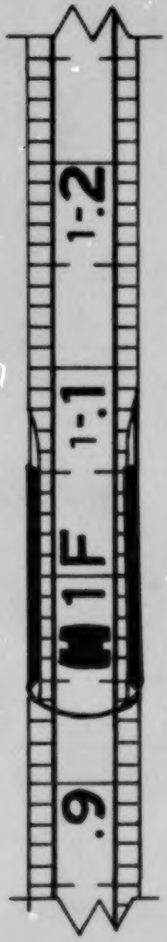
Distance Stake is to the Centerline

Slope Ratio

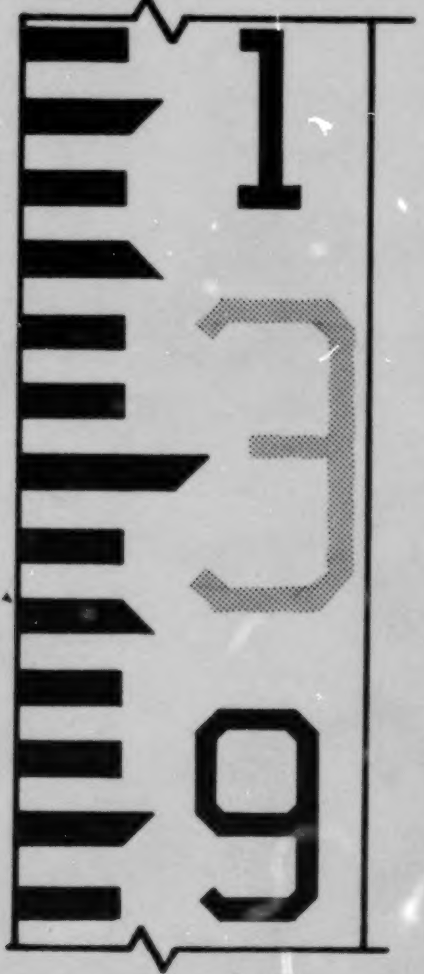
Station Number

Distance Stake is Offset from Slope Stake Point

Read the Rule and Rod



Engineer's Rule



Positive Reading Rod

TM 3

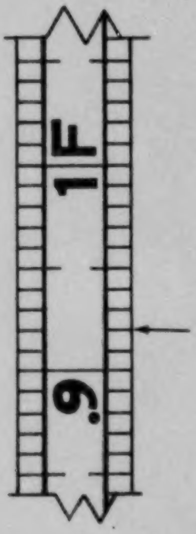
HEO I - 181-B

GRADE WORK
UNIT III

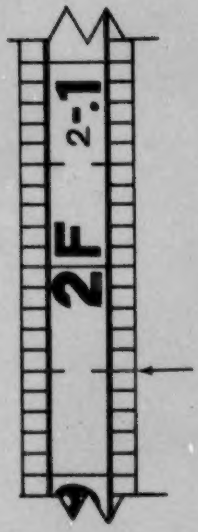
ASSIGNMENT SHEET #1--READ AN ENGINEER'S RULE

NAME ______________________________ SCORE ______________

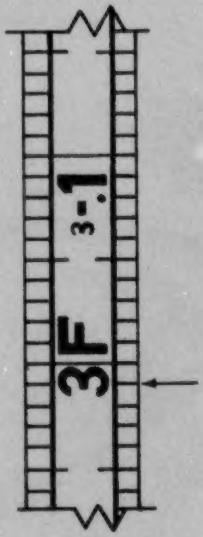
Read each of the rules below at the point indicated by the arrow. Record your results in the blanks provided.



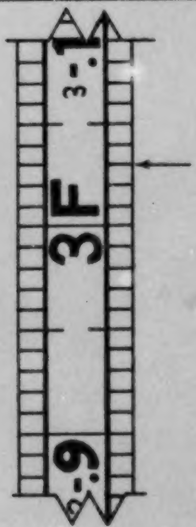
a. ______________



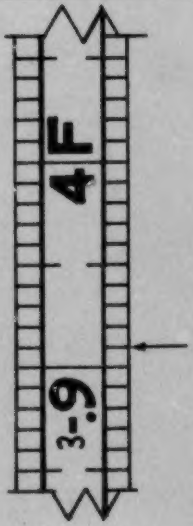
b. ______________



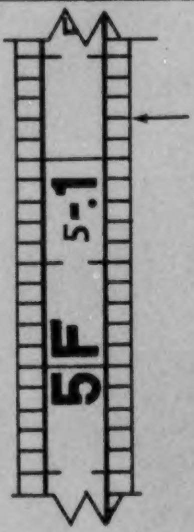
c. ______________



d. ______________



e. ______________



f. ______________

GRADE WORK
UNIT III

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

a. 0.92

b. 1.95

c. 3.09

d. 3.03

e. 3.91

f. 5.12

GRADE WORK
UNIT III

JOB SHEET #1--CHECK A CUT AND FILL

I. Tools and equipment

  A. Hand level

  B. Rod or rule

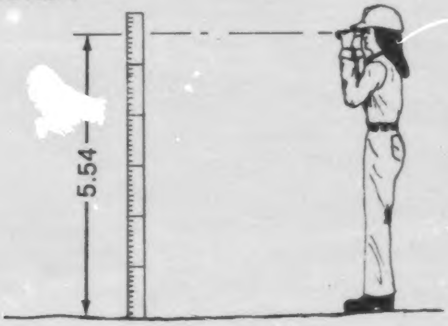
II. Procedure for cut

  A. Establish eye height

  B. Hold level to eye; center bubble at center line on glass while holding rod right in front

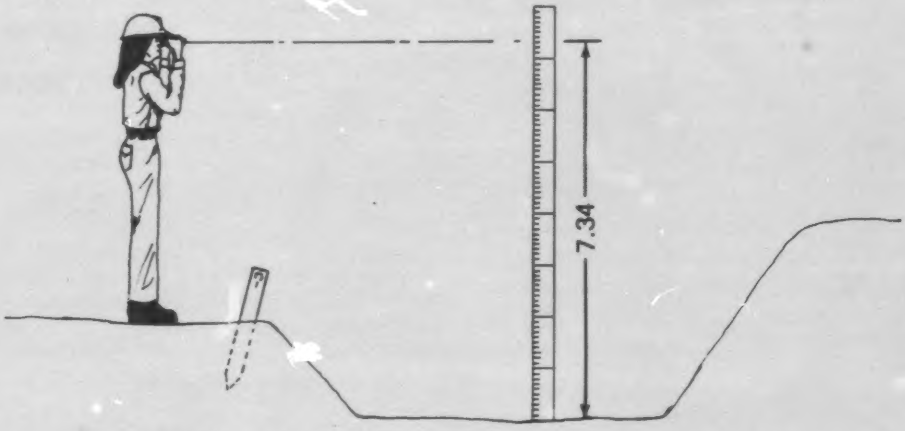
  (NOTE: The reading on the rod or rule will be the eye height. Figure 1.)

FIGURE 1



  C. Take reading on rod placed in the cut (Figure 2)

FIGURE 2



JOB SHEET #1

D. Subract eye height from reading to determine depth of cut

Example: 7.34 - 5.54 = 1.80 depth of cut

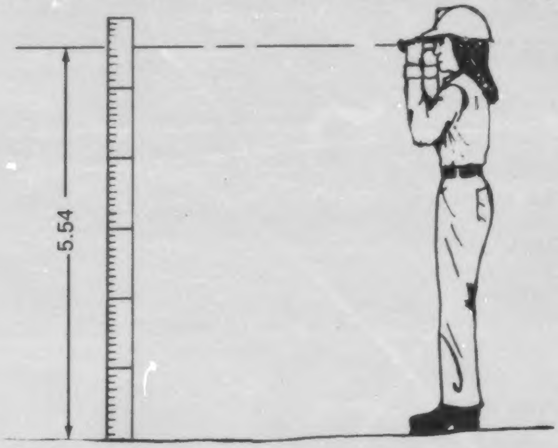
III. Procedure for fill

A. Establish eye height

B. Hold level to eye; center bubble at center line on glass while holding rod right in front

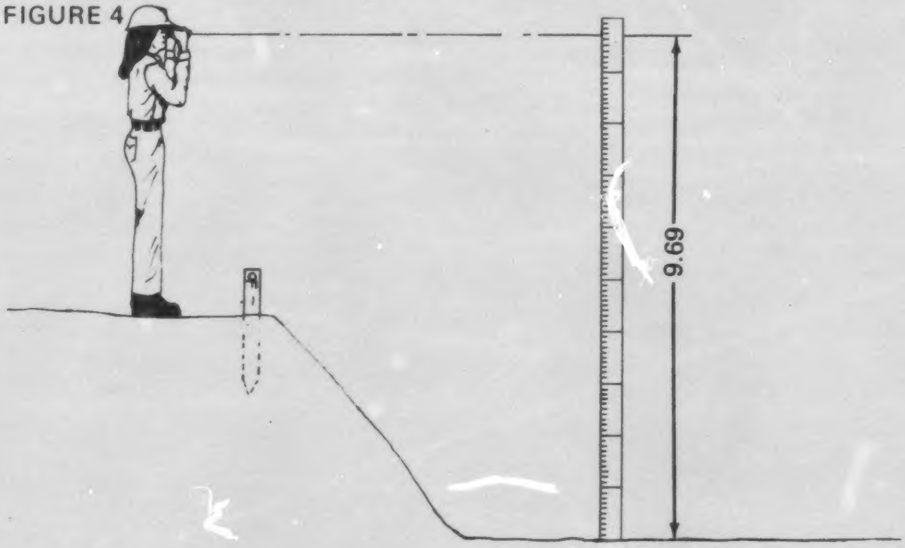
(NOTE: The reading on the rod or rule will be the eye height. Figure 3.)

FIGUER 3



C. Take reading on rod placed in the fill area (Figure 4)

FIGURE 4



JOB SHEET #1

D. Subtract eye height from reading to determine the depth of fill

Example: 9.69 - 5.54 = 4.15 depth of fill

GRADE WORK
UNIT III

JOB SHEET #2--CHECK GRADES (TRANSFER ELEVATIONS)

(NOTE: For rough grade work and relatively short horizontal distances [0.5 feet in 50 feet] a hand level is a convenient tool. For greater distance and accuracy a builder's level or transit should be used.)

I. Tools and equipment

  A. Hand level

  B. Rod or rule

  C. Bench mark

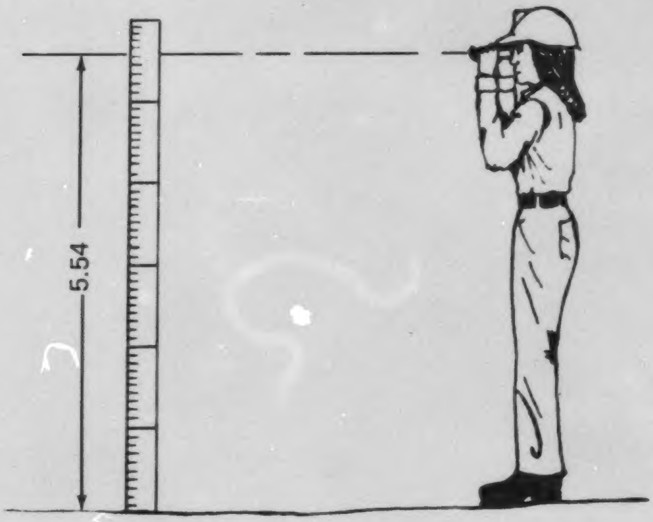
II. Procedure

  A. Establish eye height

  B. Hold level to eye; center bubble at center line on glass while holding rod or rule right in front (Figure 1)

  (NOTE: The reading on the rod will be the eye height.)

FIGURE 1

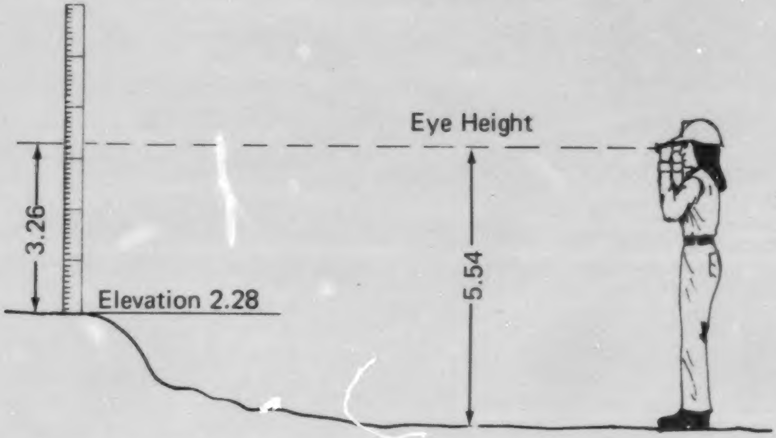


JOB SHEET #2

C. Take reading at BM (Figure 2)

(NOTE: BM added to the back sight reading on the rod gives you the height of your eye.)

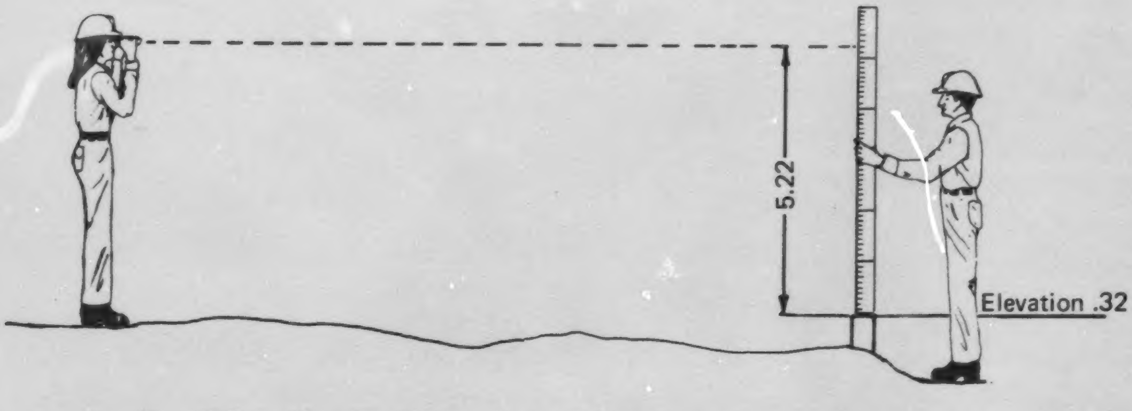
FIGURE 2


Eye Height
3.26
5.54
Elevation 2.28

D. Pivot toward point of your next reading without changing the elevation of your eye level

E. Hold level to eye and again center bubble at center line on glass while reading the elevation on rod which is held at established point by a co-worker (Figure 3)

FIGURE 3


5.22
Elevation .32

F. Follow this procedure to check all grades

GRADE WORK
UNIT III

JOB SHEET #3--TRANSFER ELEVATIONS

(NOTE: For rough grade work and relatively short horizontal distances [0.5 feet in 50 feet], a hand level is a convenient tool. For greater distance and accuracy, a builder's level or transit should be used.)

I. Tools and equipment

   A. Hand level

   B. Rod or rule

   C. Bench mark

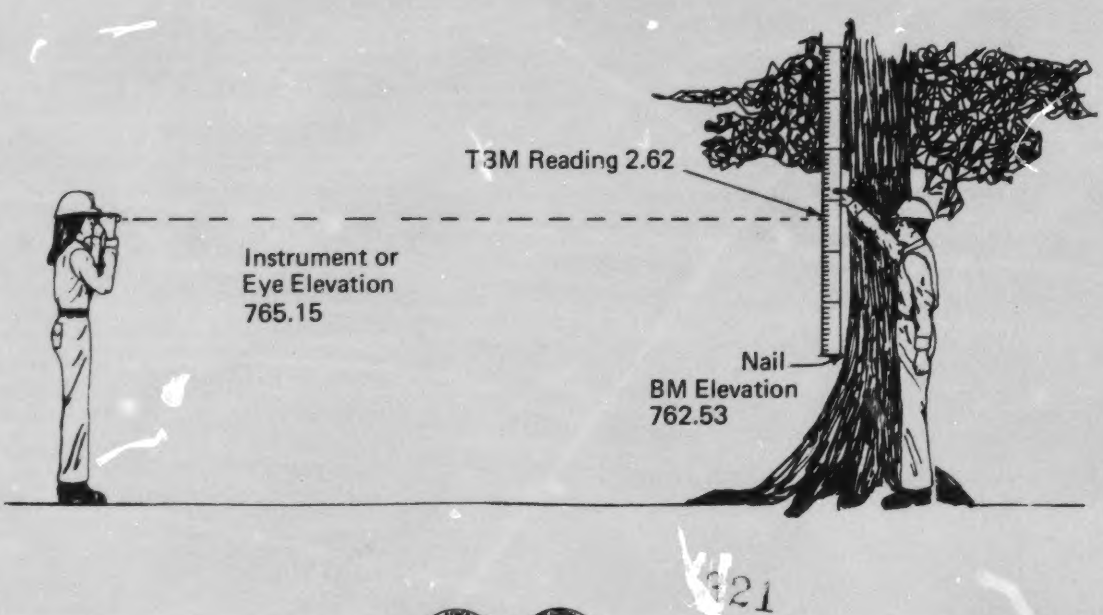
II. Procedure

   (NOTE: A TBM much be established in order to transfer elevations. You must use an immovable object, such as a rock, tree, pole, or hub stake, to set your elevation. It is desireable to locate bench mark in an area that will not be disturbed.)

   A. Have co-worker hold rod on BM

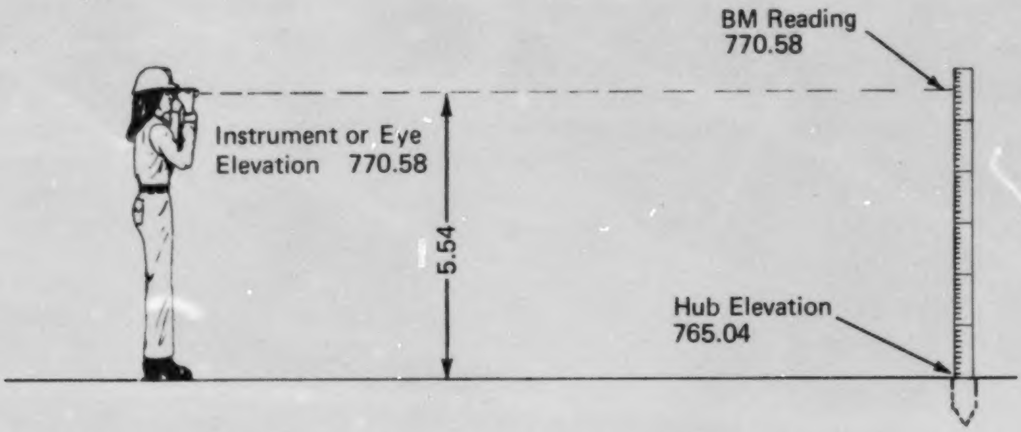
   B. Level hand level and read rod or rule through the level

   Example 1: Reading will be taken from a nail in a tree



JOB SHEET #3

Example 2: Reading will be taken from a hub stake


BM Reading
770.58
Instrument or Eye
Elevation 770.58
5.54
Hub Elevation
765.04

(NOTE: These benchmarks may be transferred to other stakes to establish the grade.)

GRADE WORK
UNIT III

JOB SHEET #4--USE A HAND LEVEL TO FIND HEIGHT OF A HILL

I. Tools and equipment

- A. Hand level
- B. Rod or rule

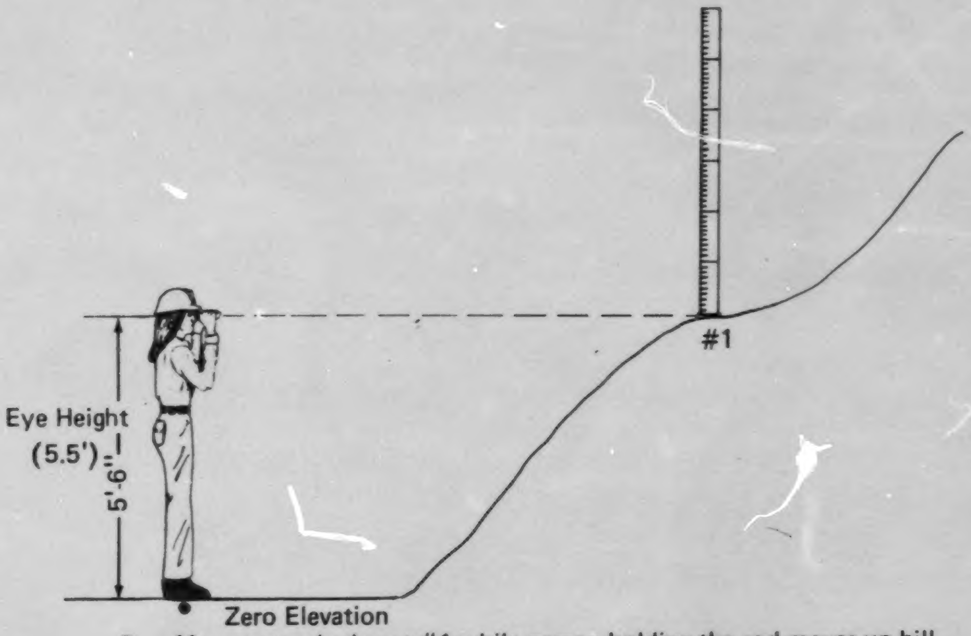
II. Procedure

- A. Hold level to eye; center bubble at center line on glass while holding rod right in front

  (NOTE: The reading on the rod or rule will be the eye height.)

- B. Hold level to eye; center bubble at center line on glass while person holding the rod moves up hill
- C. Sight through level until bottom of rod rests on ground at eye level; mark spot #1 (Figure 1)

FIGURE 1

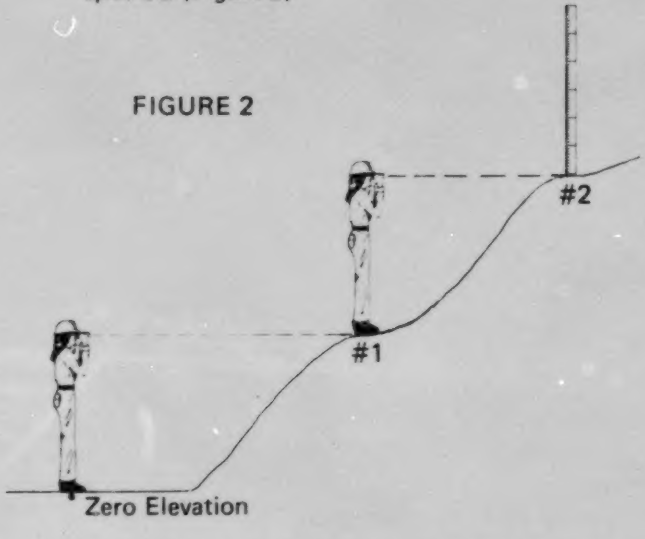


- D. Move to marked spot #1 while person holding the rod moves up hill

JOB SHEET #4

E. Sight through level until bottom of rod rests on ground at eye level; mark spot #2 (Figure 2)

FIGURE 2

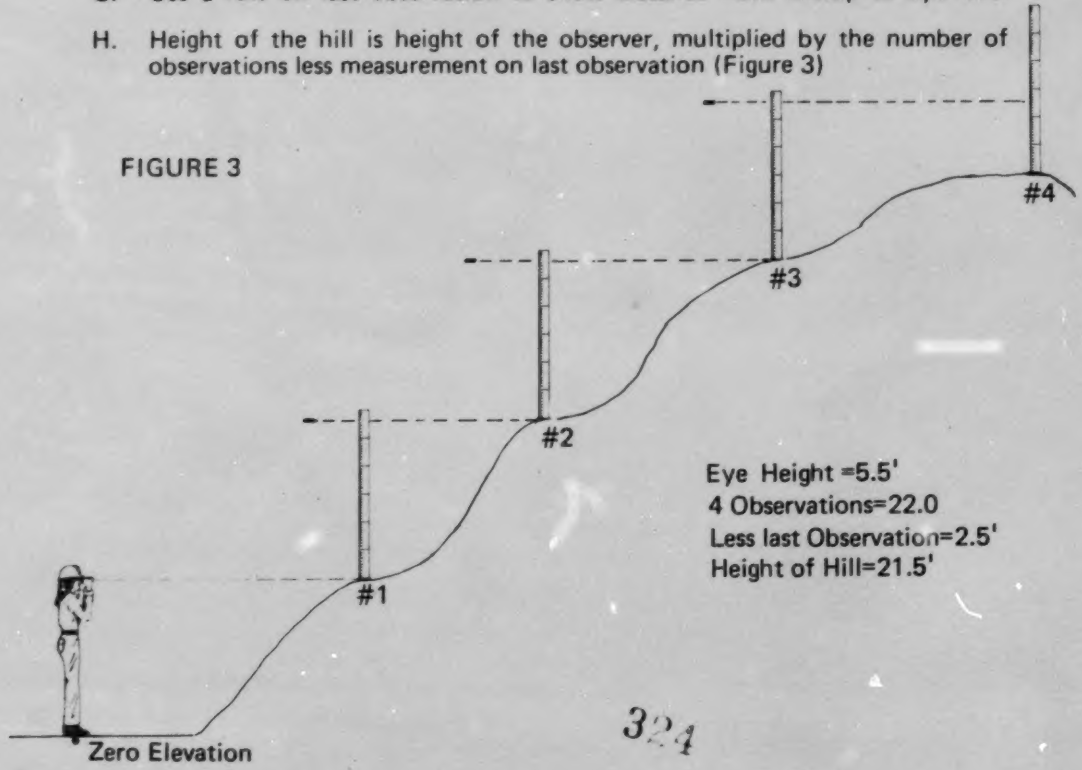


F. Continue this process until top of hill is reached

G. Use a rule on last observation to show distance from hilltop to eye level

H. Height of the hill is height of the observer, multiplied by the number of observations less measurement on last observation (Figure 3)

FIGURE 3



Eye Height =5.5'
4 Observations=22.0
Less last Observation=2.5'
Height of Hill=21.5'

GRADE WORK
UNIT III

TEST

NAME ______________________________ SCORE ____________

1. Match terms associated with grade work to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Plotting and correction of irregularities of the ground to a definite limit of grade and alignment

_____b. Mark indicating the point of a certain grade

_____c. Crayon used in construction work

_____d. Height of instrument; vertical distance from the bench mark to the line of sight of the instrument

_____e. Given grade

_____f. Permanent point of known or assumed elevation

_____g. Line through the leveling instrument as viewed by the eye; point where vertical hair crosses the horizontal hair

_____h. Temporary bench mark

_____i. Ground that forms a natural or artificial incline upward or downward

_____j. Proportion; relationship in quantity, amount, or size between two or more things

1. H.I.
2. Keel
3. Line of sight
4. Elevation
5. Grade work
6. Bench mark (BM)
7. Crowfoot
8. Ratio
9. TBM
10. Slope

2. Select from the following list the purposes of stakes. Mark each correct answer with an "X."

_____a. Indicate speed of equipment

_____b. Outline size

_____c. Indicate grades

_____d. Establish where to set up instrument ______e. Indicate center lines

______f. Hook the tape on

______g. Plot horizontal position

______h. Outline width

3. Name information given on stakes

a. ____

b. ____

c. ____

d. ____

e. ____

4. Match types of stakes to the correct uses. Write the correct numbers in the blanks provided.

______a. Mark horizontal position of work and outline direction and size of project

______b. Indicate center line of project and station number

______c. Indicate vertical dimensions of work

______d. Mark outer edge of shoulders; set with broad side facing center line of road on shoulder line

______e. Indicate amount of earth to be cut to obtain desired grade

______f. Indicate amount of material needed to bring existing ground to desired grade

______g. Indicate desired grade; no fill or cut is necessary

______h. Should be relocated away from area so that it will not be damaged or destroyed

______i. Indicate intersection of the cut or fill of outer slopes with the existing natural ground line line and the limit of earth work on each side of the center line

______j. Identify boundaries of a project

______k. Hub stakes used during the final grading process when the existing grade is within 0.2 feet of desired grade

1. Shoulder (SH)
2. Cut (C)
3. Center line (℄)
4. Offset (OF or O)
5. Alignment
6. Fill (F)
7. Grade (⊻ ⊼)
8. Slope (SS)
9. On-grade (Grade or Grd)
10. Blue tops
11. Right-of-way (R/W)

5. Describe the importance of stakes.

6. Distinguish between full station and plus station.

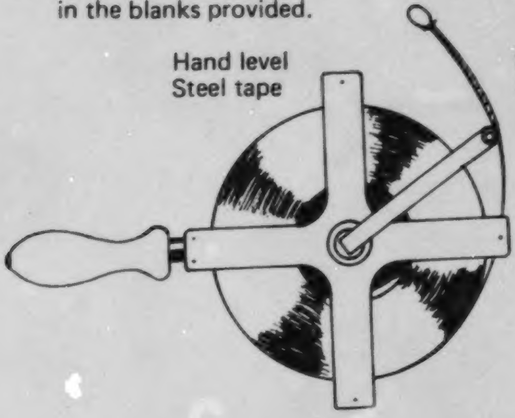
   a. Full station--

   b. Plus station--

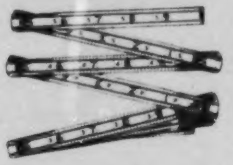
7. Identify equipment used by the operator to check stakes. Write the correct names in the blanks provided.

Hand level
Steel tape

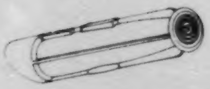
String level
Engineer's rule



a.



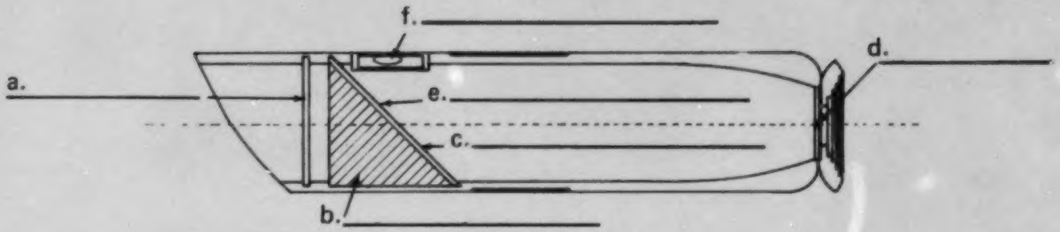
b.



c.

d.

8. Label parts of the hand level illustrated below. Write the correct names in the blanks provided.



9. Select from the following list reasons for using slope stakes. Mark each correct answer with an "X."

______a. Show distance and direction of center line

______b. Show length of the project

______c. Show steepness of curves

______d. Show necessary cut or fill

______e. Provide first markers for work crew

______f. Provide information for mechanic

______g. Provide information for engineer

______h. Show outer limits of area

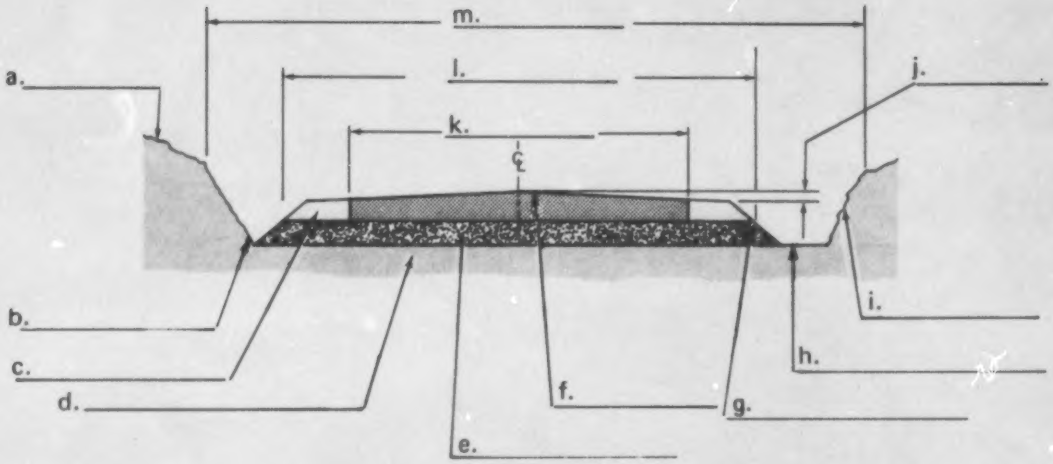
10. State the meaning of slope ratio.

______

______

______

11. Label parts of the roadbed illustrated below. Write the correct names in the blanks provided.



12. Select from the following list features of a good road design. Mark each correct answer in with an "X."

______a. Moderate curves

______b. Super elevations

______c. Type of surface

______d. Drainage

______e. Depth of ditch

______f. Type of ditch

______g. Crown

13. Arrange in order procedures for laying in a roadbed. Write a "1" in front of the first procedure, a "2" in front of the second procedure, and so on.

______a. Lay up base

______b. Finish surface course

______c. Stockpile

______d. Clearing and grubbing

______e. Excavate subgrade

______f. Establish ditches

______g. Strip top soil

14. Distinguish between backslope and foreslope.

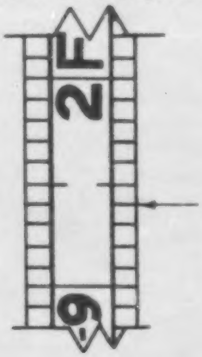
a. Backslope-- ____

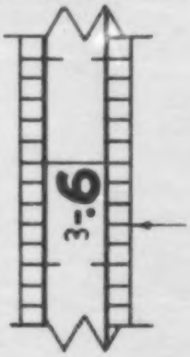
____

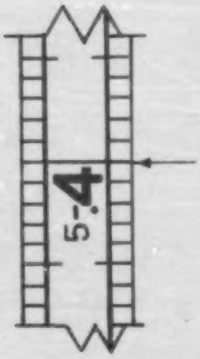
b. Foreslope-- ____

____

15. Read each of the engineer's rules below at the points indicated by the arrow.







a. ________________ b. ________________ c. ________________

16. Demonstrate the ability to:

a. Check a cut and fill.

b. Check grades (transfer elevations).

c. Transfer elevations.

d. Use a hand level to find height of a hill.

(NOTE If activity 16 has not been finished before the test, ask your instructor when it should be completed.)

GRADE WORK
UNIT III

ANSWERS TO TEST

1. a. 5
   b. 7
   c. 2
   d. 1
   e. 4
   f. 6
   g. 3
   h. 9
   i. 10
   j. 8

2. b, c, e, g, h

3. a. Type of stake
   b. Station number
   c. Required grades
   d. Locations
   e. Boundaries

4. a. 5
   b. 3
   c. 7
   d. 1
   e. 2
   f. 6
   g. 9
   h. 4
   i. 8
   j. 11
   k. 10

5. Description should include:
   a. Purpose of stakes
   b. Information found on stakes
   c. Location of stakes

6. a. Full station--Locate every 100 feet beyond starting station
   b. Plus station--Located a shorter distance from preceding station, such as on curves and rough ground, where it is necessary to set stakes closer together

7. a. Steel tape
   b. Engineer's rule
   c. Hand level
   d. String level

8. a. Glass
   b. Wood block
   c. Mirror
   d. Peep hole
   e. Image of bubble
   f. Bubble

9. a, d, e, h

10. Slope ratio--Ratio of horizontal distance to vertical distance

11. a. Existing grade
    b. V-ditch
    c. Shoulder
    d. Subgrade
    e. Base course
    f. Surface course
    g. Foreslope
    h. Flat bottom ditch
    i. Backslope
    j. Crown
    k. Travelway
    l. Roadbed
    m. Roadway

12. a, b, d, g

13. a. 5
    b. 7
    c. 3
    d. 1
    e. 4
    f. 6
    g. 2

14. a. Backslope--Extends from top of existing grade cut to bottom of ditch
    b. Foreslope--Extends from outside of shoulder to bottom of ditch

15. a. 1.94
    b. 3.57
    c. 5.4

g. Move in this direction

h. Move up

i. Wrong face, check clamp or rod upside down

j. Wave rod from side to side

12. Evaluated to the satisfaction of the instructor

13. Performance skills evaluated to the satisfaction of the instructor

SOIL
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to form opinions about how soil affects the equipment operator. The student should also be able to stabilize soil. This knowledge will be shown by completion of assignment sheets, job sheets, and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with soil to the correct definitions.
2. Distinguish between the physical properties of soil.
3. Name basic types of soils.
4. Name factors that affect soil classification.
5. Select from a list methods of stabilizing soil.
6. Name methods of applying energy to soil to attain compaction.
7. Distinguish between too wet soil and too dry soil.
8. Select from a list types of compacting equipment.
9. Match types of compaction equipment to their uses.
10. Complete checklist on how types of soil affect the equipment operator.
11. Demonstrate the ability to:
    a. Stabilize high clay content soil with hydrated lime.
    b. Field test soil.

SOIL
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and assignment sheets.
- C. Discuss unit and specific objectives.
- D. Discuss information and assignment sheets.
- E. Demonstrate and discuss procedures outlined in job sheets.
- F. Obtain samples of different soils.
- G. Give test.

II. Instructional materials:

- A. Objective sheet
- B. Information sheet
- C. Assignment Sheet #1--Complete Checklist on How Types of Soil Affect the Equipment Operator
- D. Job Sheets
  1. Job Sheet #1--Stabilize High Clay Content Soil with Hydrated Lime
  2. Job Sheet #2--Field Test Soil
- E. Test
- F. Answers to test

III. Unit references:

- A. Peurifoy, R.L. *Construction Planning, Equipment, and Methods.* 3rd ed. New York: McGraw-Hill Book Company, 1979.
- B. Nichols, Herbert L., Jr. *Moving the Earth.* 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.

SOIL
UNIT I

INFORMATION SHEET

I. Terms and definitions

  A. Soil--Loose surface material of the earth's crust

  B. Bank measure--Measure of volume of earth in its natural form

  C. Compaction--Reduction in bulk of fill by rolling, tamping, or soaking

  D. Fill--Amount of material needed to bring existing ground to desired grade

  E. Stabilize--To make soil firm and to prevent it from moving

  F. Heterogeneous--Mixture of different types of soils

  G. Homogeneous--Blend of similar or same types of soil

  H. Lift--Layer of soil placed on top of soil that was previously placed in an embankment

  I. Pass--Working movement made by an excavating, grading, or compaction machine

  J. Density--Ratio of the weight of material to its volume

  K. Organic--Partly decomposed vegetable matter with no definite particle size

  L. Optimum moisture--Desired amount of water in soil

II. Physical properties of soil

(NOTE: Volume and density of earth change considerably when excavated and compacted; therefore, it is necessary to specify how volume is measured.)

  A. Swell--Increase of volume of earth because of loosening of soil by excavation

  B. Shrinkage--Reduction of bank-measure volume due to compaction of soil

III. Basic types of soils (Assignment Sheet #1)

  A. Gravel

  B. Sand

  C. Silt

  D. Clay

INFORMATION SHEET

E. Organic

F. Rock

G. Combinations of any two or more of these

(NOTE: Sometimes it is necessary to obtain soils from different areas and then blend them; soils in their natural form may not contain the types that make up desired ratios.)

IV. Factors that affect soil classification

A. Size of particles

B. Physical properties

C. Behavior when moisture content varies

V. Methods of stabilizing soil (Assignment Sheet #1)

(NOTE: These are only a few of the methods that may be used.)

A. Blending and mixing heterogeneous soils to produce more homogeneous soils

B. Incorporating hydrated lime into soils that are high in clay content

C. Blending asphalt with the soil

D. Mixing portland cement with the soil

E. Incorporating various types of salts into soil

F. Incorporating chemicals into soil

G. Compacting soils thoroughly after they are processed

VI. Methods of applying energy to soil to attain compaction (Assignment Sheet #1)

A. Kneading

B. Static weight

C. Vibration

D. Impact

E. Combination of one or more of the above

INFORMATION SHEET

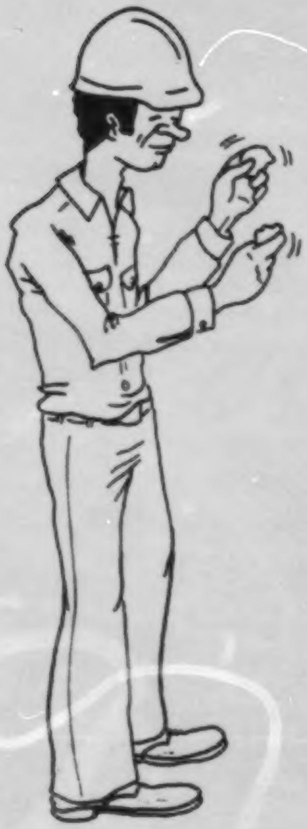
VII. Difference between too wet soil and too dry soil

(NOTE: The most critical factor in compaction of soil is the soil's moisture content. Soil can only be compacted to specifications when it contains just the right amount of water.)

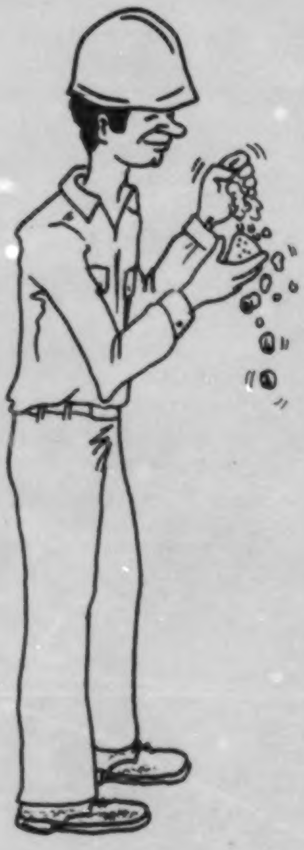
A. Too wet soil--May become rubbery under a roller and push ahead of roller and out to the sides in waves; springs back after roller passes

B. Too dry soil--May become loose or powdery under pressure, or may be firm but not dense enough; probably needs treatment of sprinkler trucks

Example:



OPTIMUM



TOO DRY

INFORMATION SHEET

VIII. Types of compacting equipment (Assignment Sheet #1)

(NOTE: These are only a few of the many types of compacting equipment available; also it may be desirable to use more than one type.)

A. Tamping rollers

B. Smooth-wheel rollers

C. Pneumatic-tired rollers

D. Vibrating rollers

E. Self-propelled vibrating plates

F. Manually-propelled vibrating plates

G. Manually-propelled compactors

H. Vibratory compactors for deep sand

IX. Types of compaction equipment and their uses

A. Smooth steel roller--All types of soil except clean sands, in layers of 4 to 12 inches depending on soil types and roller weight

B. Sheepsfoot roller--Fine grain soils of the plastic groups

C. Rubber-tired roller--Any type soil if weight and tire pressure are proper for soil types

D. Impact of air, hydraulic, or gasoline hammer or vibrator--Trench fills and other small areas

(NOTE: Vibration is most effective in sand or gravel soils but may increase the effectiveness of a roller in many soils.)

E. Grid roller--Used to break down or crush rock

SOIL
UNIT I

ASSIGNMENT SHEET #1--COMPLETE CHECKLIST ON HOW TYPES OF SOIL AFFECT THE EQUIPMENT OPERATOR

NAME ________________________________ SCORE ______________

1. Which basic types of soil are most often found in your local area?

_____a. Gravel

_____b. Sand

_____c. Silt

_____d. Clay

_____e. Organic

_____f. Combinations of any two or more of these

_____g. Other-- ____

____

____

2. a. Which method or methods of stabilizing soil are most often used in your local area or by your contractor?

_____1) Blending and mixing heterogeneous soils to produce more homogeneous soils

_____2) Incorporating hydrated lime into soils that are high in clay content

_____3) Blending asphalt with the soil

_____4) Mixing portland cement with the soil

_____5) Incorporating various types of salts into soil

_____6) Incorporating chemicals into soil

_____7) Compacting soils thoroughly after they are processed

_____8) Other-- ____

____

ASSIGNMENT SHEET #1

b. In your opinion, why is this the most common method used in your locality?

(NOTE: You may want to ask your instructor, superintendent, or co-workers for their opinions also.)

________________________ ________________________

____

____

3. a. Which method of applying energy to soil to obtain compaction is used by your contractor or used in your locality?

_____1) Kneading

_____2) Static weight

_____3) Vibration

_____4) Impact

_____5) Combination of one or more of the above

_____6) Other-- ________________________________

____

____

b. In your opinion, why is this method used in your locality?

____

____

____

4. a. Which of the following pieces of compaction equipment is most often used by your contractor or used in your locality?

_____1) Tamping rollers

_____2) Smooth-wheel rollers

_____3) Pneumatic-tired rollers

_____4) Vibrating rollers

_____5) Self-propelled vibrating plates

ASSIGNMENT SHEET #1

_____6) Manually-propelled vibrating plates

_____7) Manually-propelled compactors

_____8) Vibratory compactors for deep sand

_____9) Other-- ____

b. In your opinion, why is this equipment used most often in your locality?

____

____

____

SOIL
UNIT I

JOB SHEET #1--STABILIZE HIGH CLAY CONTENT SOIL WITH HYDRATED LIME

(NOTE: This procedure may not be applicable in every locality.)

I. Materials and equipment

   A. Hydrated lime

   B. Spreader

   C. Soil-stabilizer or disc harrow

   D. Compactor

   E. Sprinkler equipped tank truck

II. Procedure

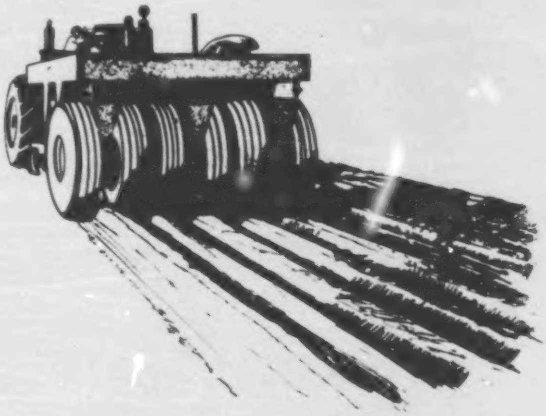
   (NOTE: Specifications call for the upper 6 inches of subgrade to be stabilized with 5 percent, by weight, of hydrated lime.)

   A. Spread lime over area

   B. Blend soil and lime together using soil stabilizer (Figure 1)

      (NOTE: Follow preliminary mixing with a 48-hour curing period.)

      FIGURE 1



   C. Remix soil

   D. Compact soil thoroughly to desired density

   E. Use sprinkler equipment to damp cure for 7 days

SOIL
UNIT I

JOB SHEET #2--FIELD TEST SOIL

(NOTE: The purpose of a field test is to determine if optimum moisture content is being maintained.)

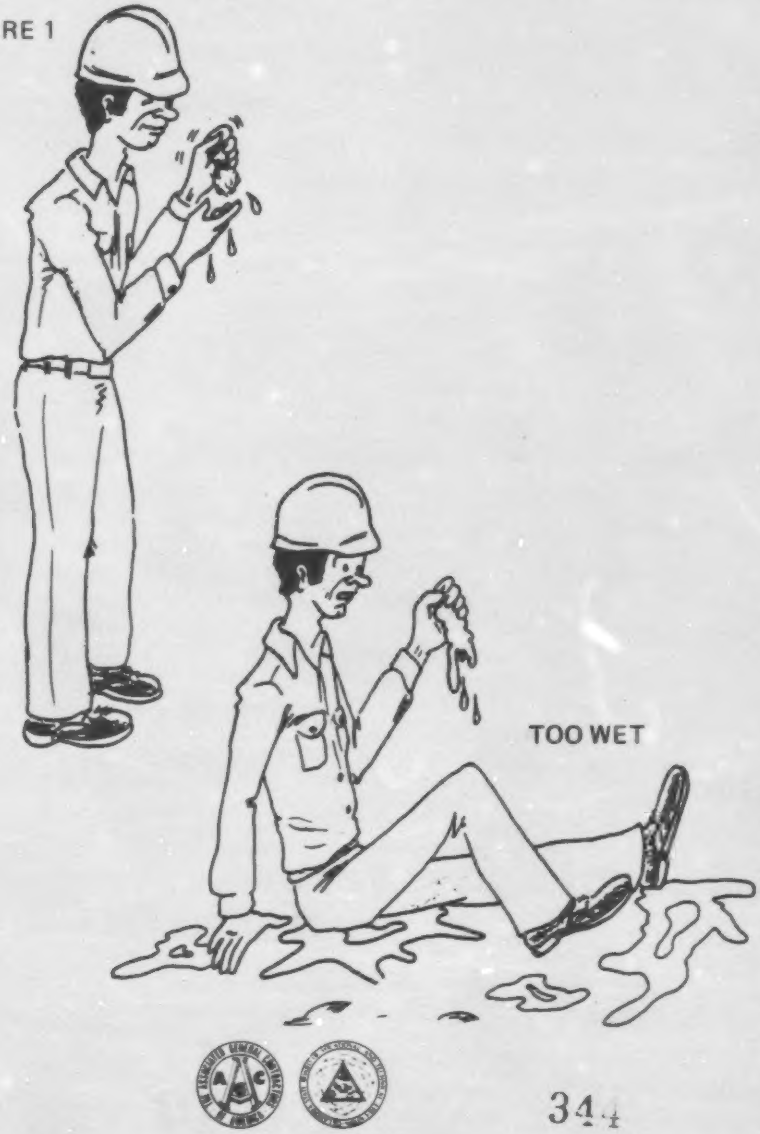
I. Material--Sample of soil

II. Procedure

A. Obtain a sample of material being spread in lifts

B. Attempt to form soil into a ball; if it will not form, it is too wet (Figure 1)

FIGURE 1

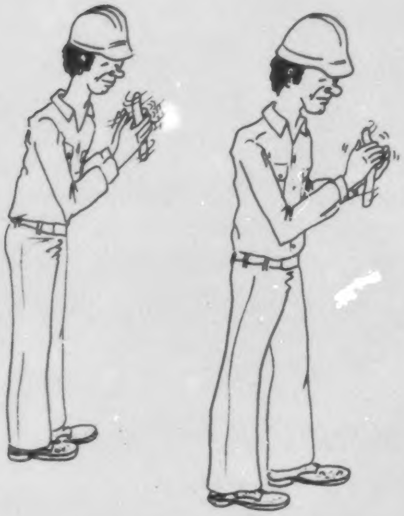


JOB SHEET #2

C. Try to break soil ball into equal halves

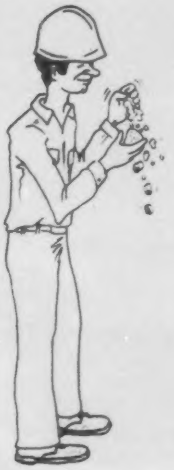
1. If ball stretches or is elongated, it is still too wet (Figure 2)

FIGURE 2



2. If ball crumbles, it is too dry (Figure 3)

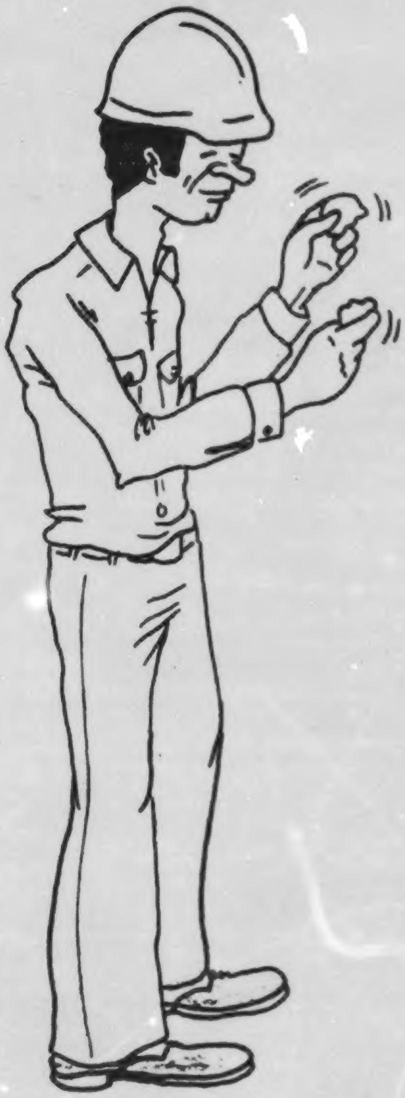
FIGURE 3



JOB SHEET #2

D. Continue taking samples and testing; when ball breaks cleanly without much crumbling, optimum is okay (Figure 4)

FIGURE 4



OPTIMUM

SOIL
UNIT I

TEST

NAME ______________________ SCORE ______________

1. Match terms associated with soil to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Loose surface material of the earth's crust

_____b. Measure of volume of earth in its natural form

_____c. Reduction in bulk of fill by rolling, tamping, or soaking

_____d. Amount of material needed to bring existing ground to desired grade

_____e. To make soil firm and to prevent it from moving

_____f. Mixture of different types of soils

_____g. Blend of similar or same types of soil

_____h. Layer of soil placed on top of soil that was previously placed in an embankment

_____i. Working movement made by an excavating, grading, or compaction machine

_____j. Ratio of the weight of material to its volume

_____k. Partly decomposed vegetable matter with no definite particle size

_____l. Desired amount of water in soil

1. Fill
2. Heterogeneous
3. Lift
4. Pass
5. Bank measure
6. Density
7. Soil
8. Organic
9. Compaction
10. Stabilize
11. Homogeneous
12. Optimum moisture

2. Distinguish between the physical properties of soil. Place an "X" in the blank before swell and an "O" in the blank before shrinkage.

_____a. Increase of volume of earth because of loosening of soil by excavation

_____b. Reduction of bank-measure volume due to compaction of soil

3. Name basic types of soils.

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

   e. ____________________

   f. ____________________

   g. ____________________

4. Name factors that affect soil classification.

   a. ____________________

   b. ____________________

   c. ____________________

5. Select from the following list methods of stabilizing soils. Mark each correct answer with an "X."

   ______a. Mixing concrete with soils

   ______b. Incorporating chemicals into soil

   ______c. Blending and mixing heterogeneous soils to produce more homogeneous soils

   ______d. Excavating soils

   ______e. Blending asphalt with the soil

   ______f. Using tractor test

   ______g. Incorporating hydrated lime into soils that are high in clay content

   ______h. Incorporating various types of salts into soil

6. Name methods of applying energy to soil to attain compaction.

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

   e. ____________________

7. Distinguish between too wet soil and too dry soil.

Too wet soil--____

____

____

Too dry soil--____

____

____

8. Select from the following list types of compacting equipment. Mark each correct answer with an "X."

_____a. Pneumatic-tired rollers

_____b. Pneumatic kneading machine

_____c. Self-propelled vibrating plates

_____d. Smooth-wheel rollers

_____e. Shrinkage matts

_____f. Dump trucks

_____g. Manually-propelled vibrating plates

_____h. Hydraulic vibrating rollers

_____i. Tamping rollers

_____j. Rotating tamping rollers

9. Match types of compaction equipment to their uses. Write the correct numbers in the blanks provided.

_____a. All types of soil except clean sands, in layers of 4 to 12 inches depending on soil types and roller weight

_____b. Fine grain soils of the plastic groups

_____c. Any type soil if weight and tire pressure are proper for soil types

_____d. Trench fills and other small areas

_____e. Used to break down or crush rock

1. Rubber-tired roller
2. Grid roller
3. Sheepsfoot roller
4. Smooth steel roller
5. Impact of air, hydraulic, or gasoline hammer or vibrator

10. Complete checklist on how types of soil affect the equipment operator.

11. Demonstrate the ability to:

    a. Stabilize high clay content soil with hydrated lime.

    b. Field test soil.

    (NOTE: If activities 10 and 11 have not been finished before the test, ask the instructor when they should be completed.)

SOIL
UNIT I

ANSWERS TO TEST

1. a. 7 h. 3
   b. 5 i. 4
   c. 9 j. 6
   d. 1 k. 8
   e. 10 l. 12
   f. 2
   g. 11

2. a. X
   b. O

3. a. Gravel
   b. Sand
   c. Silt
   d. Clay
   e. Organic
   f. Rock
   g. Combinations of any two or more of these

4. a. Size of particles
   b. Physical properties
   c. Behavior when moisture content varies

5. b, c, e, g, h

6. a. Kneading
   b. Static weight
   c. Vibration
   d. Impact
   e. Combination of one or more of the above

7. a. Too wet soil--May become rubbery under a roller and push ahead of roller and out to the sides in waves; springs back after roller passes

   b. Too dry soil--May become loose or powdery under pressure, or may be firm but not dense enough; probably needs treatment of sprinkler trucks

8. a, c, d, g, i

9. a. 4

   b. 3

   c. 1

   d. 5

   e. 2

10. Evaluated to the satisfaction of the instructor

11. Performance skills evaluated to the satisfaction of the instructor

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to load and unload heavy equipment. This knowledge will be shown by completion of job sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with load, lash, and unload to the correct definitions.
2. State safety precautions for loading and moving equipment.
3. List types of equipment used to move heavy equipment.
4. Select from a list devices used to load equipment.
5. State reasons for side loading equipment.
6. List precautions to take when side loading.
7. Discuss why and how pavement should be protected.
8. Select from a list steps to take when securing (lashing) equipment.
9. Demonstrate the ability to:
    a. Load bulldozer from rear.
    b. Unload bulldozer from rear.

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

- A. Provide student with objective sheet.
- B. Provide student with information and job sheets.
- C. Discuss unit and specific objectives.
- D. Discuss information sheet.
- E. Demonstrate and discuss procedures outlined in job sheet.
- F. Give test.

II. Instructional materials:

- A. Objective sheet
- B. Information sheet
- C. Job sheets
    1. Job Sheet #1--Load Bulldozer from Rear
    2. Job Sheet #2--Unload Bulldozer from Rear
- D. Test
- E. Answers to test

III. Unit references

- A. Nichols, Herbert L., Jr. *Moving the Earth*. 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.
- B. American Hoist and Derrick Company, *Cableco Catalog No. 950-5*. Los Angeles, California: Cabeleco, 1968.

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Cribbing--To line or support with timber framework

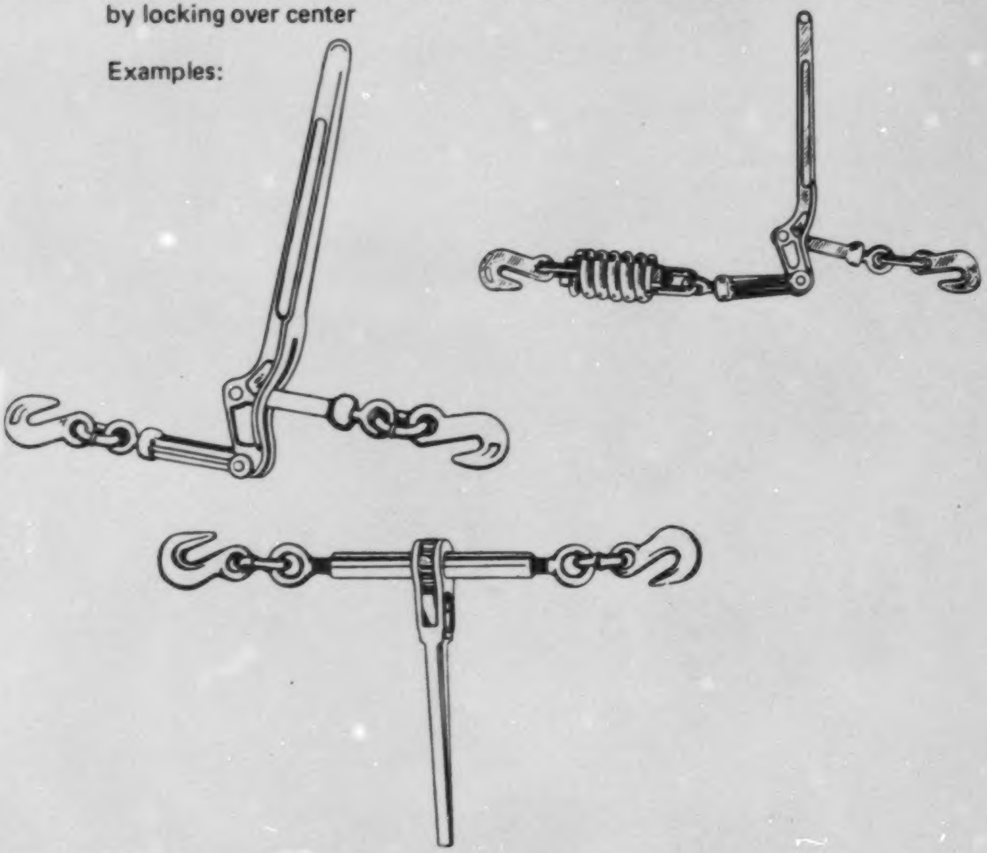
B. Grouser--Ridge or cleat across a track shoe, which improves traction

C. Dolly--Unit consisting of a draw tongue, an axle with wheels, and a turntable platform to support a trailer gooseneck

D. Blocks--Wooden, triangular shapes to fit track or tires

E. Load binders--Levers that pull two grab hooks together and hold them by locking over center

Examples:



F. Center of gravity--Refers to the point where dozer is balanced at top of ramp

INFORMATION SHEET

II. Safety precautions for loading and moving equipment

(NOTE: Permits are required when moving equipment.)

- A. Signal before moving
- B. Use crawler blocks and safety chains
- C. Use signal person when clearances are close
- D. Never overload trailer
- E. Know height, width, and weight of load
- F. Use substantial ramp or blocking when loading
- G. Set swing brake and/or lock
- H. Be sure all loose gear, outrigger beams, and pads are secure
- I. Follow manufacturer's instructions when towing
- J. Travel with lights on
- K. Use proper signs and warning flags
- L. Do not exceed bridge load limits
- M. Watch for narrow spots and low clearances
- N. Allow for boom overhang and structure clearances when turning corners
- O. Slow down when crossing obstacles
- P. Watch height clearance when moving boom equipment

  (NOTE: Uneven ground may cause boom to bob and weave enough to contact obstructions.)

- Q. Tie down or cover rain cap

  (NOTE: This will keep turbo from windmilling.)

III. Types of equipment used to move heavy equipment

(NOTE: Always use a trailer of sufficient size for the equipment you are hauling.)

- A. Girder frame deck trailer with stationary gooseneck
- B. Deck trailer with detachable gooseneck
- C. Extra-heavy trailer with multiple dollies

INFORMATION SHEET

  D. Girder or I-beam trailer

  E. Low bed trailer (low-boy)

  F. Tilt-bed trailer

  G. Dump truck

  H. Flatbed truck with tilting-roll back bed

IV. Devices used to load equipment

  A. Wood planks

  B. Steel box or channels

  C. Wood reinforced with steel plates or angles

  D. Blocking

  E. Cribbing

  F. Dirt banks

  (NOTE: Quite often loading is simplified by backing or pulling the trailer alongside a bank or into a deep gutter.)

  G. Self loaders

  (NOTE: Large tractors can walk on a trailer from ground level, pulling the trailer down with its grousers.)

V. Reasons for side loading equipment

  A. More convenient in small areas

  B. Shorter and lighter ramps may be used

  C. Drop-deck models are lower at sides

  D. Sometimes only blocks are needed

VI. Precautions to take when side loading

  A. Do not lay ramps on the edge of deck

  B. Be sure to block trailer before attempting to load

  C. Take special care when loading large equipment from side; turning may be very difficult

  D. Be sure weight is distributed evenly

INFORMATION SHEET

E. Do not rest any part of load over tires unless the part is high enough for tires to turn freely

F. Be sure all machines are blocked and tied down when transporting

G. Avoid loading when wet, muddy, or icy

VII. Why and how pavement should be protected

A. Why

1. Prevent scuffing during turns
2. Prevent crushing of oiled or blacktop pavements
3. Prevent bruising of pavements
4. Prevent digging in of grousers

(NOTE: Many localities prohibit crawler equipment on streets.)

B. How

1. Planking
2. Covering with a layer of dirt
3. Cribbing
4. Mats
5. Rubber tires

VIII. Securing (lashing) equipment

A. Leave equipment in gear with clutch engaged and brakes locked

B. Place blocks at each end of both tracks or tires

C. Fasten chains from each corner of equipment to the D loops on the trailer sides or fasten chain to loop on one side of trailer then over equipment to loop on other side and tighten

(NOTE: At least two of these chains should be tightened and locked with load binders.)

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

JOB SHEET #1--LOAD A BULLDOZER FROM REAR

I. Equipment and materials

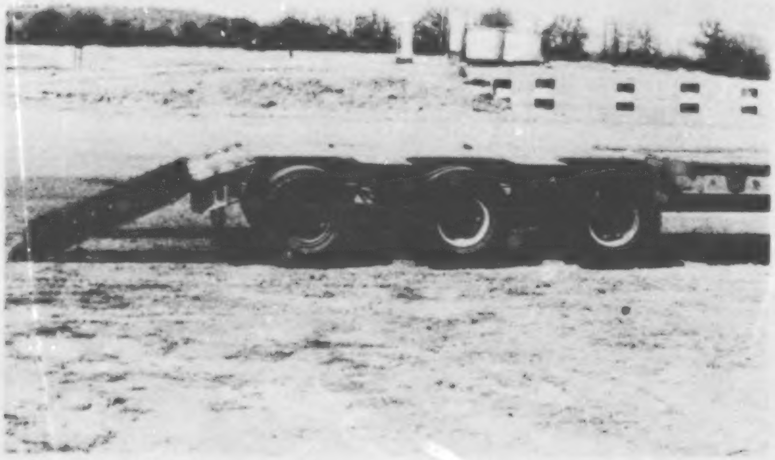
- A. Bulldozer
- B. Trailer
- C. Ramp
- D. Blocks
- E. Chains
- F. Load binders

II. Procedure

- A. Drop ramps to ground (Figure 1)

  (NOTE: Place substantial supports under ramps if necessary.)

  FIGURE 1

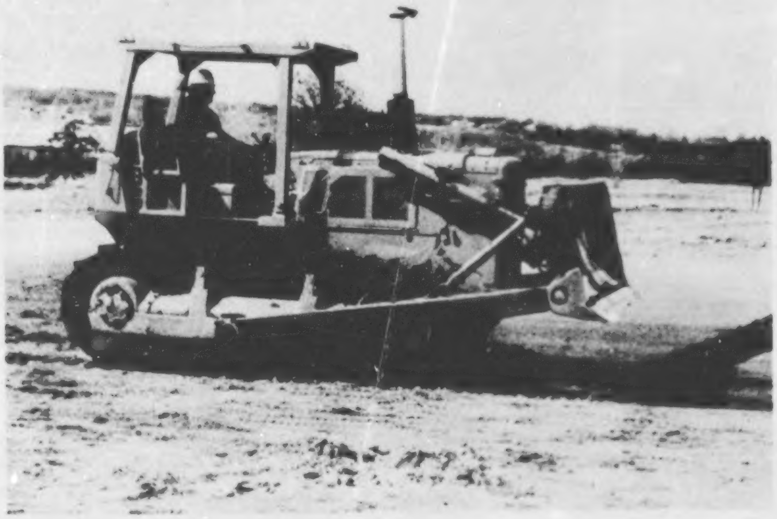


JOB SHEET #1

B. Pull dozer up to ramp (Figure 2)

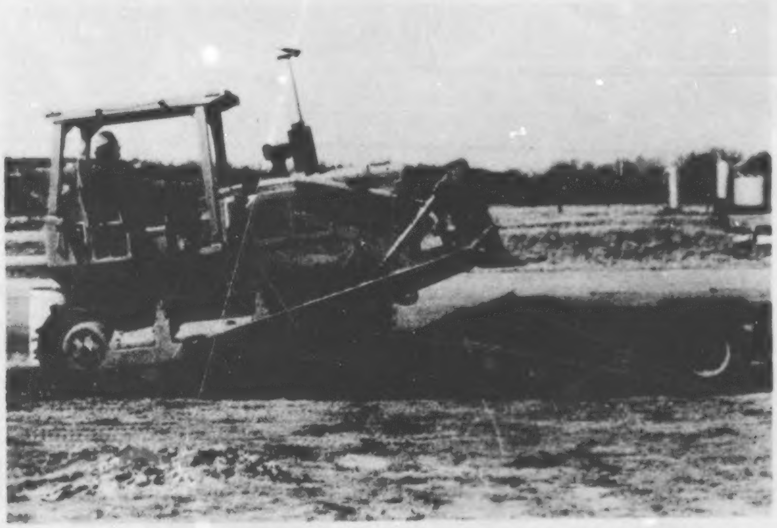
(NOTE: Check to see that tracks line up with ramp.)

FIGURE 2



C. Select low gear and start up ramp very slowly and cautiously (Figure 3)

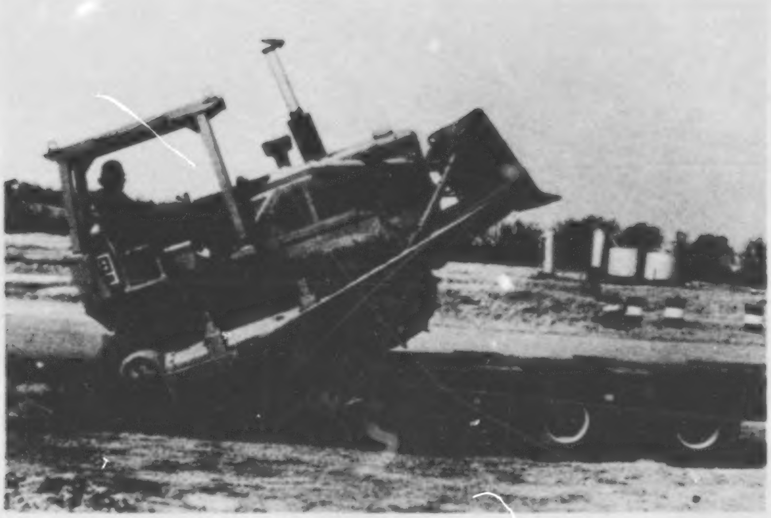
FIGURE 3



JOB SHEET #1

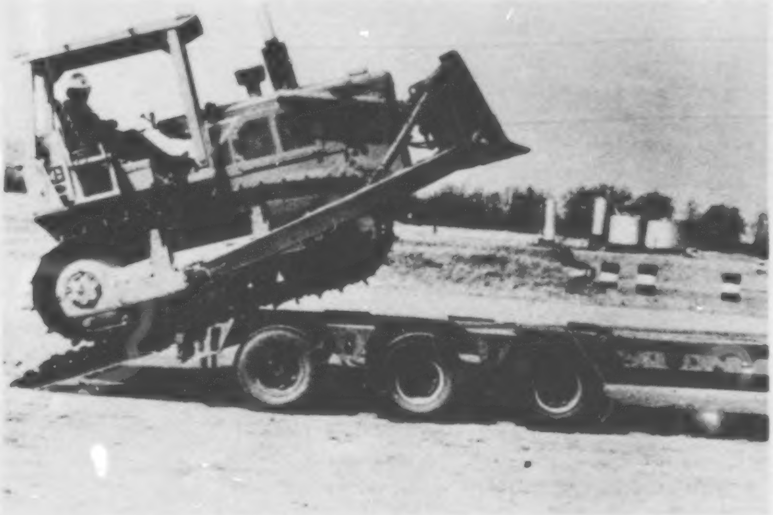
D. Continue moving up ramp until center of gravity is reached (Figure 4)

FIGURE 4



E. Continue moving forward very cautiously to avoid too much of a jar (Figure 5)

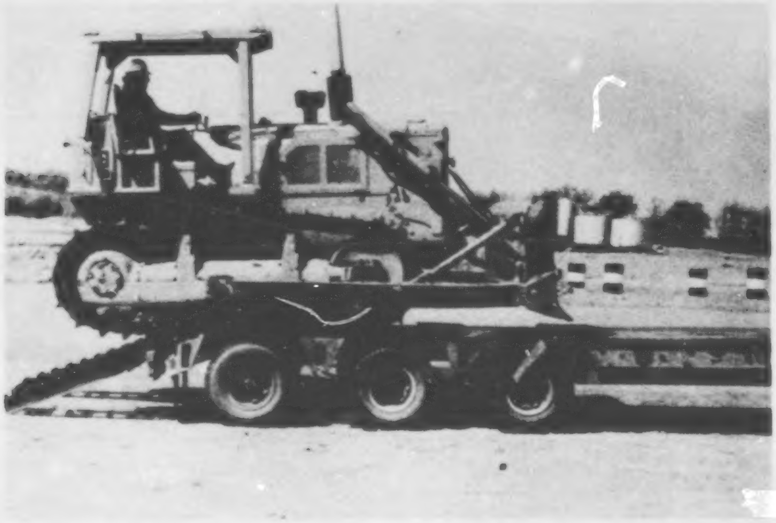
FIGURE 5



JOB SHEET #1

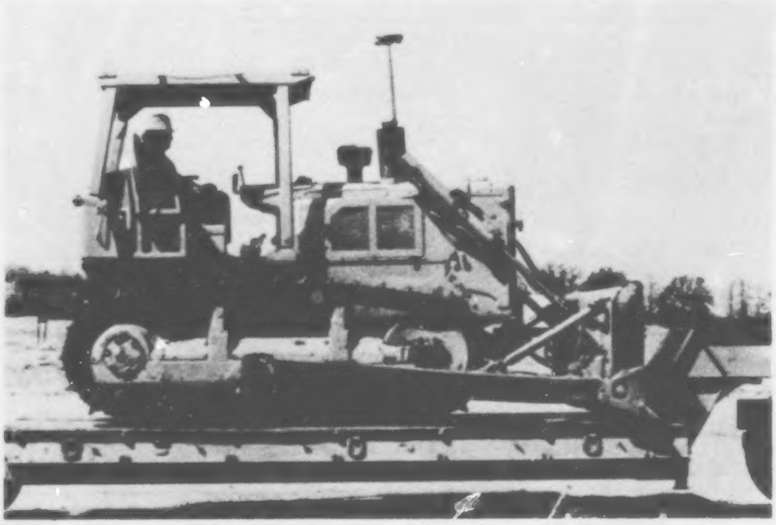
F. Continue moving forward and aligning bulldozer on trailer (Figure 6)

FIGURE 6



G. Continue moving to front of trailer and correct position for lashing; lower blade to deck and apply brakes (Figure 7)

FIGURE 7



JOB SHEET #1

H. Fasten two chains from drawbar to D loops toward rear of trailer on each side

I. Fasten a chain to each side of blade and run to D rings on opposite sides of trailer

J. Use load binders to snug chains

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

JOB SHEET #2–UNLOAD BULLDOZER FROM REAR

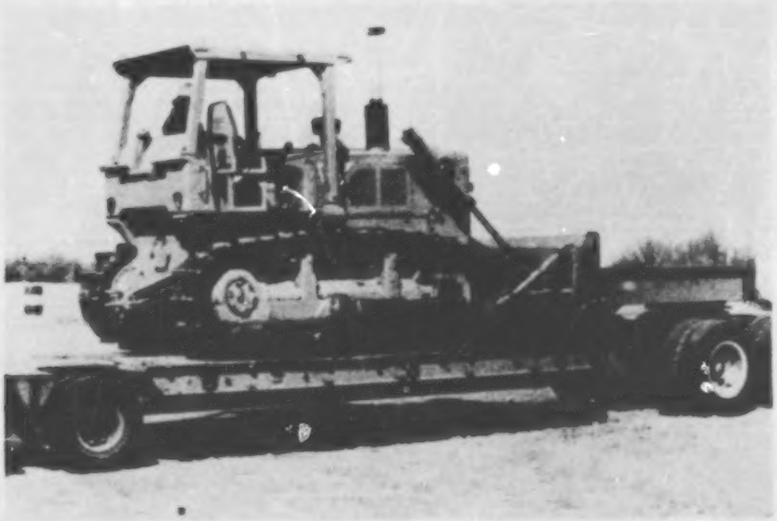
I. Equipment and materials

- A. Bulldozer
- B. Trailer
- C. Blocks
- D. Chains
- E. Load binders

II. Procedure

- A. Remove load binders, chains, and blocks
- B. Start bulldozer (Figure 1)

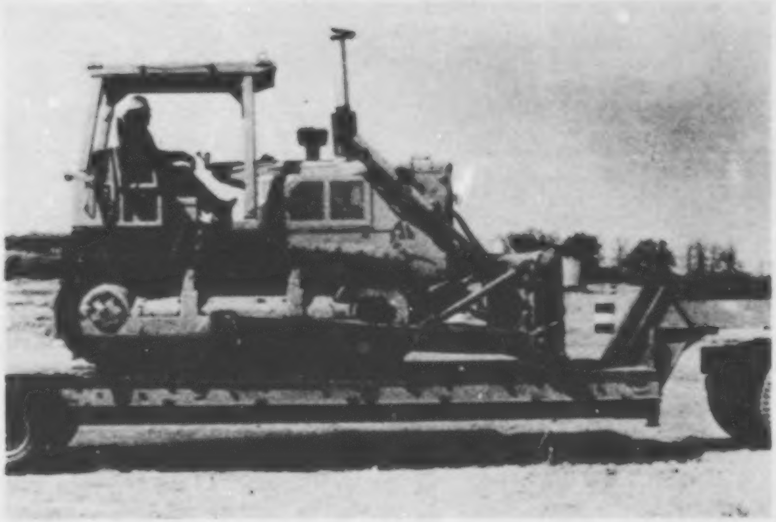
FIGURE 1



JOB SHEET #2

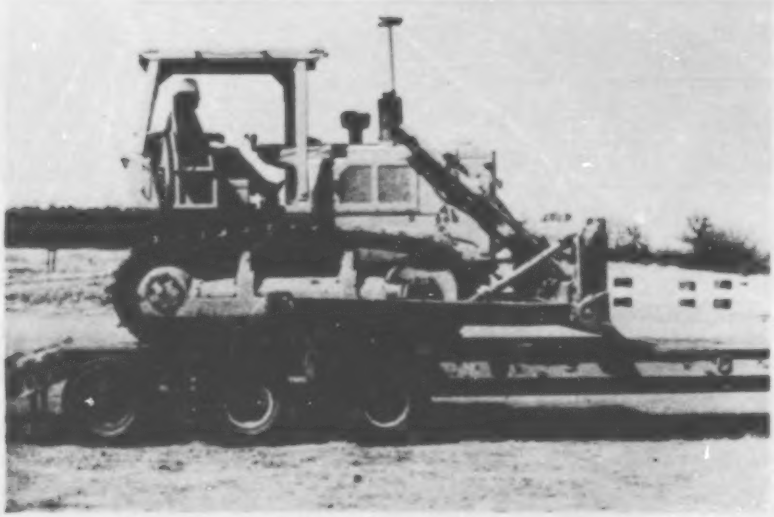
C. Select low gear, raise blade slightly, and start moving backwards (Figure 2)

FIGURE 2



D. Continue moving backwards cautiously and aligning bulldozer with ramps (Figure 3)

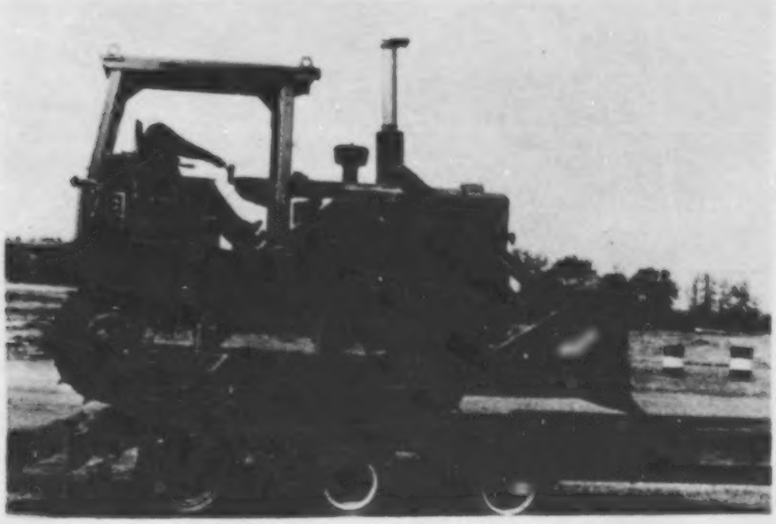
FIGURE 3



JOB SHEET #2

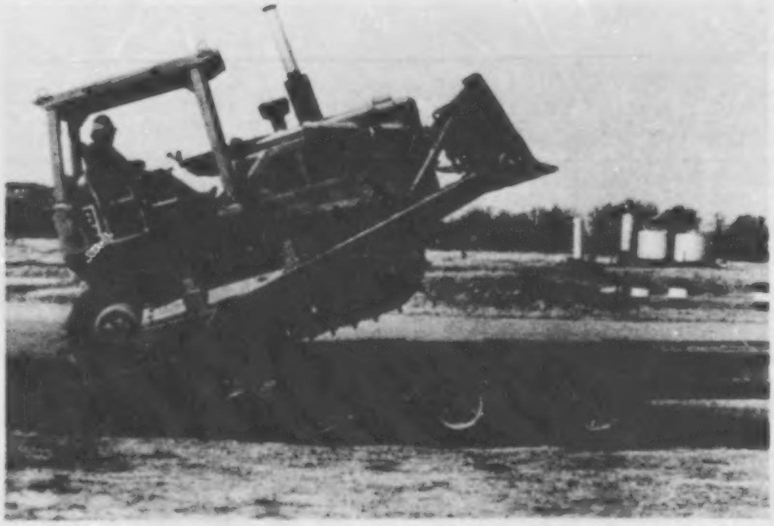
E. Continue backwards to end of trailer (Figure 4)

FIGURE 4



F. Raise blade and continue moving very cautiously over center of gravity (Figure 5)

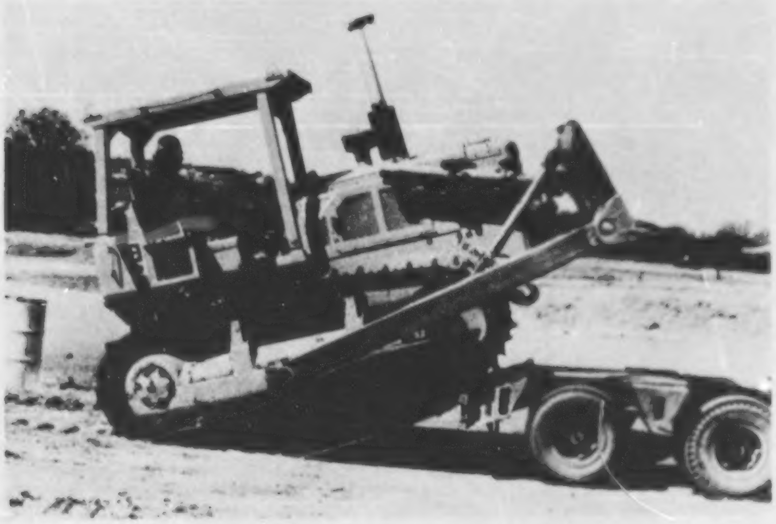
FIGURE 5



JOB SHEET #2

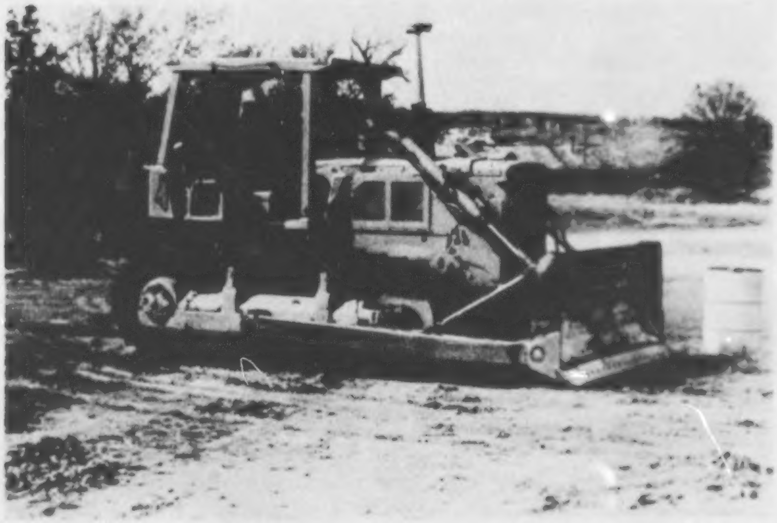
G. Continue moving down ramp to the ground (Figure 6)

FIGURE 6



H. Move tractor completely off of ramps and away from trailer (Figure 7)

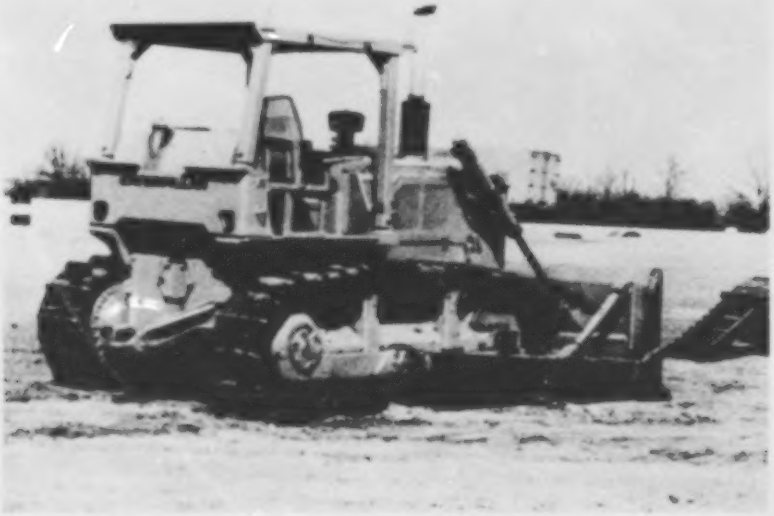
FIGURE 7



JOB SHEET #2

I. Secure bulldozer and dismount (Figure 8)

FIGURE 8



LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with load, lash, and unload to the correct definitions. Write the correct numbers in the blanks provided.

_____a. To line or support with timber framework

_____b. Ridge or cleat across a track shoe, which improves traction

_____c. Unit consisting of a draw tongue, an axle with wheels, and a turntable platform to support a trailer gooseneck

_____d. Wooden, triangular shapes to fit track or tires

_____e. Levers that pull two grab hooks together and hold them by locking over center

_____f. Refers to the point where dozer is balanced at top of ramp

1. Grouser
2. Blocks
3. Cribbing
4. Load binders
5. Dolly
6. Center of gravity

2. State ten safety precautions for loading and moving equipment.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

3. List five types of equipment used to move heavy equipment.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

4. Select from the following list devices used to load equipment. Mark each correct answer with an "X."

______a. Self loaders

______b. Steel channel irons

______c. Wood planks

______d. Cribbing

______e. Concrete blocks

______f. Dirt piles

______g. Wood reinforced with steel plates or angles

______h. I-beams

5. State reasons for side loading equipment.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

6. List five precautions to take when side loading.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

7. Discuss why and how pavement should be protected.

   a. Why--____

   ____

   ____

   ____

   ____

   b. How--____

   ____

   ____

   ____

   ____

8. Select from the following list steps to take when securing (lashing) equipment. Mark each correct answer with an "X."

   _____a. Place blocks at each end of both tracks or tires

   _____b. Take equipment out of gear and release brakes

   _____c. Leave equipment in gear with clutch engaged and brakes locked

   _____d. Fasten chains from each corner of equipment to the D loops on the trailer sides or fasten chain to loop on one side of trailer then over equipment to loop on other side and tighten

   _____e. Fasten rope to loop on the side of trailer then over equipment to loop on other side and tighten

   _____f. Fasten chain completely around equipment

9. Demonstrate the ability to:

   a. Load bulldozer from rear.

   b. Unload bulldozer from rear.

   (NOTE: If these activities have not been finished before the test, ask your instructor when they should be completed.)

LOAD, LASH, AND UNLOAD EQUIPMENT
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 1
   c. 5
   d. 2
   e. 4
   f. 6

2. Any ten of the following:
   a. Signal before moving
   b. Use crawler blocks and safety chains
   c. Use signal person when clearances are close
   d. Never overload trailer
   e. Know height, width, and weight of load
   f. Use substantial ramp or blocking when loading
   g. Set swing brake and/or lock
   h. Be sure all loose gear, outrigger beams, and pads are secure
   i. Follow manufacturer's instructions when towing
   j. Travel with lights on
   k. Use proper signs and warning flags
   l. Do not exceed bridge load limits
   m. Watch for narrow spots and low clearances
   n. Allow for boom overhang and structure clearances when turning corners
   o. Slow down when crossing obstacles
   p. Watch height clearance when moving boom equipment
   q. Tie down or cover rain cap

3. Any five of the following:
   a. Girder frame deck trailer with stationary gooseneck
   b. Deck trailer with detachable gooseneck
   c. Extra-heavy trailer with multiple dollies
   d. Girder or I-beam trailer
   e. Low bed trailer (low-boy)
   f. Tilt-bed trailer
   g. Dump truck
   h. Flatbed truck with tilting-roll back bed
4. a, c, d, g
5. a. More convenient in small areas
   b. Shorter and lighter ramps may be used
   c. Drop-deck models are lower at sides
   d. Sometimes only blocks are needed
6. Any five of the following:
   a. Do not lay ramps on the edge of deck
   b. Be sure to block trailer before attempting to load
   c. Take special care when loading large equipment from side; turning may be very difficult
   d. Be sure weight is distributed evenly
   e. Do not rest any part of load over tires unless the part is high enough for tires to turn freely
   f. Be sure all machines are blocked and tied down
   g. Avoid loading when wet, muddy, or icy
7. Discussion should include:
   a. Why
      1) Prevent scuffing during turns
      2) Prevent crushing of oiled or blacktop pavements
      3) Prevent bruising of pavements
      4) Prevent digging in of grousers

b. How

   1) Planking

   2) Covering with a layer of dirt

   3) Cribbing

   4) Mats

   5) Rubber tires

8. a, c, d

9. Performance skills evaluated to the satisfaction of the instructor

RIGGING
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to calculate safe working loads, spreading angles, and sling stress, and be able to safely rig loads using good rigging practices. This knowledge will be evidenced by completion of assignment sheets, job sheets, and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with rigging to the correct definitions.
2. Identify accessories used for load lifting.
3. Identify hitches used for attaching materials and equipment to the hoist.
4. Label elements of knots, bends, and hitches.
5. Match types of knots to the correct uses.
6. State safety tips related to rigging.
7. Match types of materials used in construction of ropes to their characteristics.
8. Explain general construction of rope.
9. State precautions to observe when caring for ropes.
10. Calculate safe working load (SWL) of different types and sizes of ropes.
11. State the importance of spreading angles.
12. Calculate sling stress.
13. Distinguish among hand signals used in rigging operations.
14. Select from a list construction characteristics of wire rope used with heavy equipment.
15. Match strengths of steel used in wire rope to their grades.
16. Calculate safe working load (SWL) of different sizes of wire ropes.

17. Arrange in order steps to take when performing maintenance on wire rope.

18. Label types of snatch blocks.

19. Select from a list types of cable fittings.

20. Identify types of towing chains and accessories.

21. Select from a list good rigging practices.

22. Distinguish among types of knots.

23. Demonstrate the ability to:

    a. Tie knots.

    b. Install wire rope clips.

    c. Rig and handle different types of loads.

RIGGING
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information, assignment, and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Have students purchase *Handbook for Riggers* to use for reference.

  H. Have students pair off and practice hand signals.

  I. Furnish students with rope to tie knots.

  J. Give test.

II. Instructional materials:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Elements of Knots, Bends, and Hitches
    2. TM 2--Sling Angle and Load Factors
    3. TM 3--Sling Angles
    4. TM 4--Formula for Calculating Sling Stress
    5. TM 5--Hoist Signals
    6. TM 6--Standard Hand Signals for Boom Operation
    7. TM 7--Standard Hand Signals for Boom Operation (Continued)
    8. TM 8--Standard Hand Signals for Boom Operation (Continued)
    9. TM 9--Standard Hand Signals for Boom Operation (Continued)
    10. TM 10--Maneuvering Vehicles

11. TM 11–Wire Rope Fittings

12. TM 12–Wire Rope Fittings (Continued)

D. Assignment sheets

1. Assignment Sheet #1--Distinguish Among Types of Knots

2. Assignment Sheet #2--Calculate Safe Working Load (SWL) of Different Types and Sizes of Rope

3. Assignment Sheet #3--Calculate Sling Stress

4. Assignment Sheet #4--Distinguish Among Hand Signals Used in Rigging Operations

5. Assignment Sheet #5--Calculate Safe Working Load (SWL) of Different Sizes of Wire Ropes

6. Assignment Sheet #6--Identify Bad Rigging Practices

E. Answers to assignment sheets

F. Job sheets

1. Job Sheet #1–Tie Knots

2. Job Sheet #2–Install Wire Rope Clips

3. Job Sheet #3–Rig and Handle Different Types of Loads

G. Test

H. Answers to test

III. Unit references:

A. Smith, Earl L. *Power Line Technician's Training*. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Material Center and Rural Electric Cooperatives of Oklahoma, 1978.

B. Hendrix, Laborn J. "Bud." *Millwright Instructional Materials*. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

C. Nichols, Herbert L., *Moving the Earth*. 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.

D. Nichols, Herbert L., Jr. *Heavy Equipment Repair*. Greenwich, Connecticut: North Castle Books, 1964.

E. Rossnagel, W. E. *Handbook of Rigging*. 3rd ed. New York: McGraw-Hill Book Company, 1964.

F. Newberry, W. G. (Bill). *Handbook for Riggers*. 2nd ed. Canada: Printed in Canada, ISBNO-9690154-1-0, 1977.

(NOTE: Address requests for handbook to W. G. (Bill) Newberry; P.O. Box 2999; Calgary, Alberta, Canada; T2P 2M7.)

RIGGING
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Rigging--Setting up block and tackle to a winch, stacking and hoisting material and equipment, and/or replacing cables on equipment

B. Hitch--To attach a rope to a post, pole, ring, hook, or other object

C. Tagline--Rope used to guide and/or steady load

D. Heaved--Pulled from underneath the load

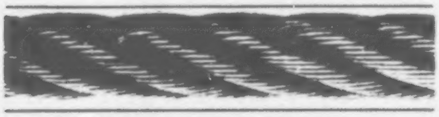
E. Tackle--Assembly of blocks and lines used to aid in lifting or pulling

F. Sheave--Grooved wheel or pulley

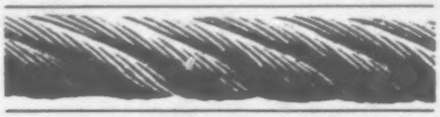
G. Preforming--Preliminary shaping of wires so that they will lie in place

H. Lay--Direction, length, or angle of twist of strands in a rope or cable

Examples:



Right, regular-lay rope



Right, Lang-lay wire rope

Left, regular-lay rope

Left, Lang-lay wire rope

I. Snatch block--Pulley in a case which can be easily fastened to lines or objects by means of a hook, ring, or shackle

J. Core--Material used in the center of wire rope

K. Spreaders--Devices used to prevent crushing of load and to lift extra long and heavy loads

L. psi--Pounds per square inch

M. Center of gravity--Point at which entire weight may be considered as concentrated

INFORMATION SHEET

N. Eye--Metal loop which engages a hook

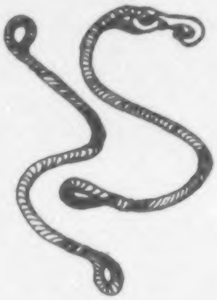
O. Thimble--Grooved metal ring inserted in loop of rope to prevent wear

P. Dog--Slang meaning to deliberately slow down the work pace

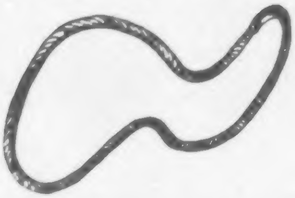
Q. Splice--To join two parts of a rope or wire to form a continuous length

II. Accessories used for load lifting

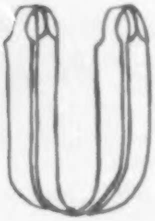
A. Chokers (single slings)



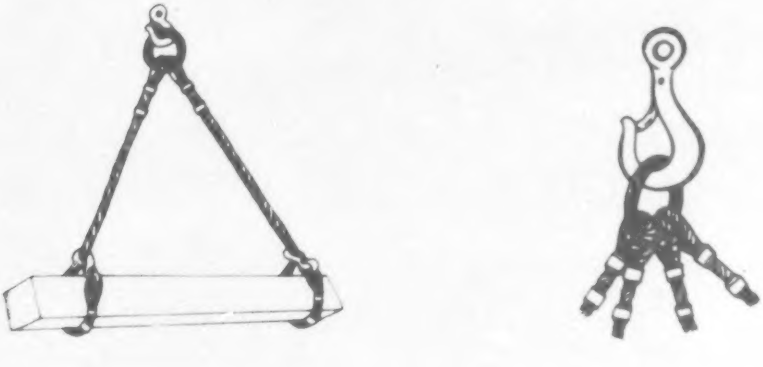
B. Grommet sling



C. Web sling



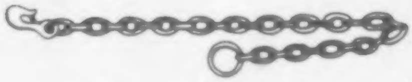
D. Bridles



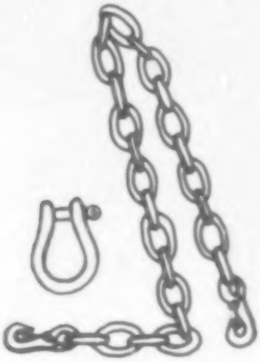
INFORMATION SHEET

E. Bull chain

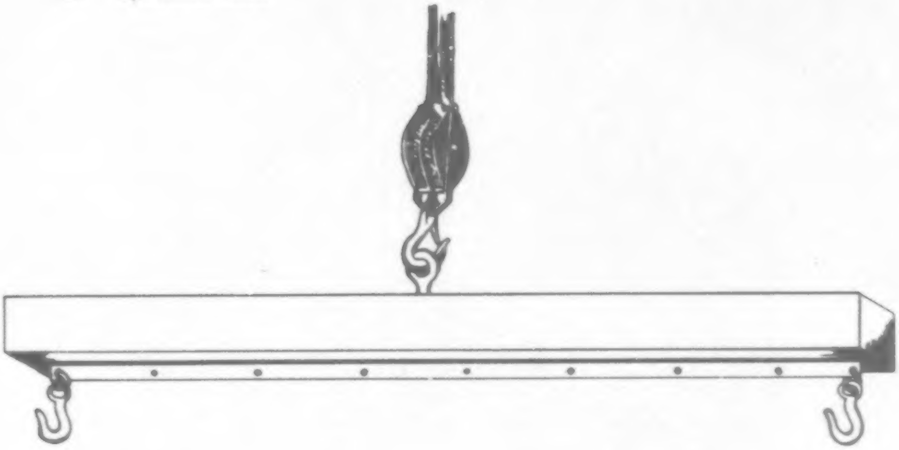
(NOTE: Chains are used mainly for towing and for securing equipment.)

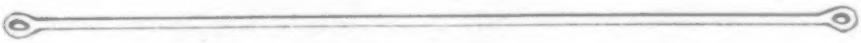


F. Chain and shackle



G. Spreader bars



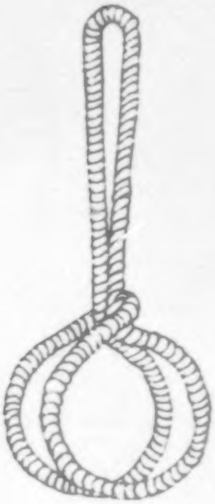


INFORMATION SHEET

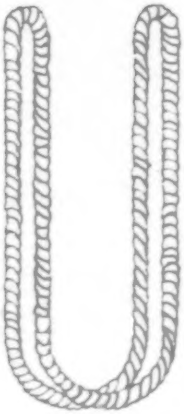
III. Hitches used to attach materials and equipment to the hoist

(CAUTION: The placement of hitches on the load is very critical. Caution must be taken to be sure hitches are made secure and safe.)

A. Choker hitch sling

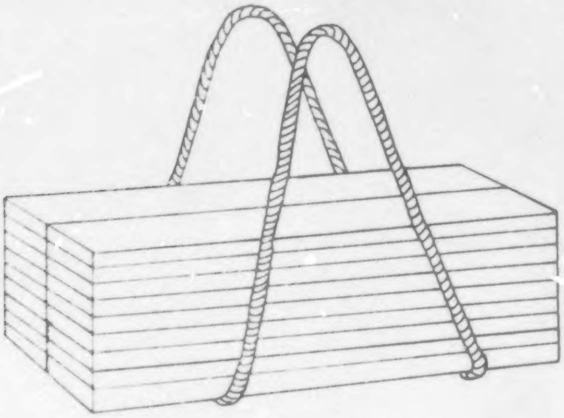


B. Basket hitch sling

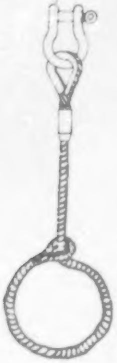


INFORMATION SHEET

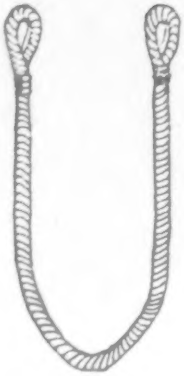
C. Inverted basket hitch sling



D. Choker hitch choker



E. Basket hitch choker



INFORMATION SHEET

IV. Elements of knots, bends, and hitches (Transparency 1)

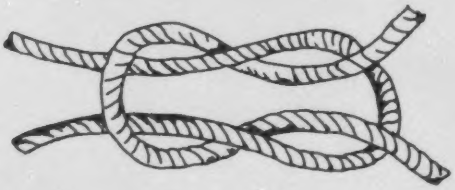
- A. Bight
- B. Overhand loop
- C. Underhand loop
- D. Running end
- E. Whipping
- F. Round turn
- G. Turn
- H. Standing part

V. Correct uses of types of knots (Assignment Sheet #1; Job Sheet #1)

(NOTE: Efficiency of manila rope decreases considerably when using knots and splices.)

Example:
Straight rope = 100% strength
Bowline = 53% strength
Eye splice = 85% strength
Square knot = 43% strength
Clove hitch = 75% strength
Sheepshank = 35% strength

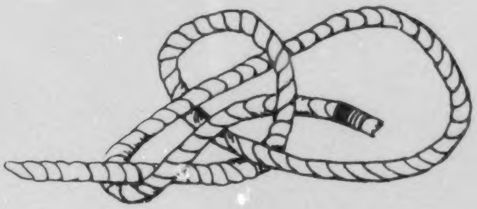
A. Square knot--Ties two lines of equal size together so that they will not slip



INFORMATION SHEET

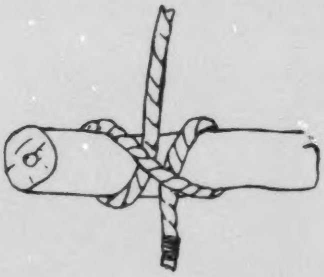
B. Bowline--Forms a single loop that will not tighten or slip under strain

(NOTE: This is one of the best knots to use to lower people or materials.)



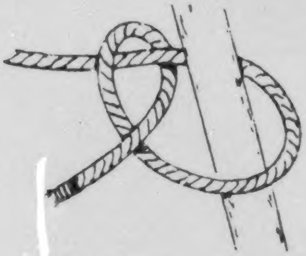
C. Clove hitch–Fastens a line to timber or pipe

(NOTE: This is probably one of the most widely used knots.)



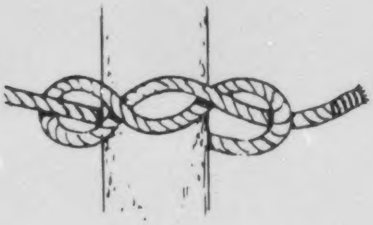
D. Half hitch–Ties line to timber or to a larger line

(NOTE: This is a quick and easy knot to use when tying down a tarp or plastic covering.)

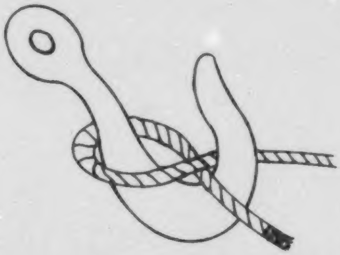


INFORMATION SHEET

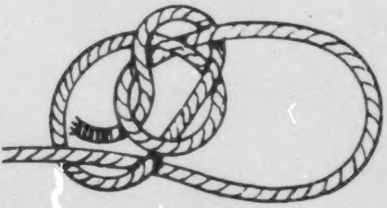
E. Timber hitch--Holds timber securely when moving heavy timber or poles because of the pressure of one coil over other; the more tension applied, the tighter the hitch



F. Blackwall hitch--Fastens a line to a hook; generally used temporarily

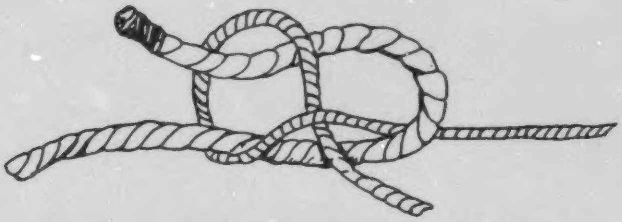


G. Running bowline--Forms a strong running loop which is convenient for running an eye; can also provide a choker-type sling at the end of a line

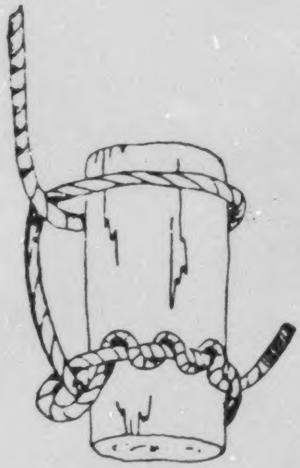


INFORMATION SHEET

H. Sheet bend–Ties two lines of unequal size together; also used to tie a line to an eye

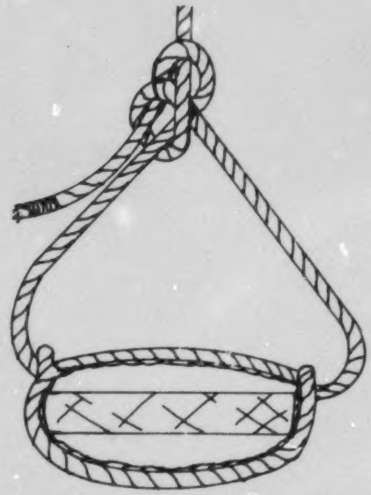


I. Timber hitch with half hitch--Holds heavy timbers or poles for lifting or dragging

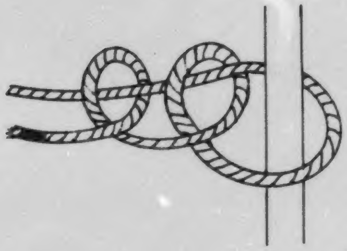


INFORMATION SHEET

J. Scaffold hitch--Supports ends of scaffold plank and prevents it from tilting



K. Two half hitches--Secures running end of line to standing part



INFORMATION SHEET

VI. Safety tips related to rigging

A. Use personal protective devices such as goggles, gloves, safety shoes, and hard hats

B. Use tagline to guide and/or steady load

C. Do not walk under load

D. Be sure load is balanced properly

E. Do not overload equipment

F. Use corner saddles, padding, or wood blocking to protect slings from sharp bends and sharp edges

G. Stand clear when slings are heaved from under loads

H. Avoid heavy or continuous overloading

I. Be sure outriggers and/or stabilizers are in use and are on solid footing

J. Lubricate slings to prevent rust

K. Be sure all hooks have safety snaps

L. Be extra cautious around power lines

(CAUTION: There must be a minimum of ten feet between equipment and power lines. Check local requirements.)

VII. Characteristics and types of materials used in construction of ropes

A. Natural fibers

1. Manila--Strong and durable; used where dependability, ability to stand up under severe use, and weathering are required

2. Sisal--Less durable, lower in strength; used where requirements are less demanding and low cost is a major factor

B. Synthetic ropes

1. Nylon--Very strong, approximately twice the strength of manila; unusually high abrasion resistance, good resistance to weathering, and high degree of stretch

2. Terylene--Quite similar to nylon except somewhat lower in tensile strength and having much less stretch

3. Polypropylene--Slightly less strength than nylon, but a degree of stretch similar to terylene; very light, actually floats on water and is resistant to rot

INFORMATION SHEET

4. Polyethylene–Has about same strength as polypropylene, but has a high stretch factor and excellent resistance to mildew, decay, acids, and alkalies

VIII. General construction of rope

A. Rope is normally made of three strands, each of which is made of several threads

B. The rope itself is twisted in a right-hand direction while each strand is twisted in a left-hand direction and the individual threads are twisted in a right-hand direction

C. Reversal of twist in strands gives the rope a balance or set which eliminates the tendency to unwind

IX. Precautions to observe when caring for ropes

A. When taking rope from a coil, always remove it from the center in a counter-clockwise direction

B. When rope is not in use, it should be re-coiled in a clockwise direction

C. When rope is attached to a hook, ring, or pully block, a thimble should be placed in the loop or eye to reduce wear and to decrease stress

D. Protect rope from moisture and weather as much as possible

E. Do not disturb a frozen rope until completely thawed

F. Keep rope away from acids, other chemicals, and heat

G. Do not drag rope over ground or sharp edges

H. If possible, do not make abrupt bends in rope

I. Dirty rope should be washed and dried before being stored

J. Store rope so that air may circulate around it

(NOTE: Hang rope in loose coils or place on wood grating above the floor.)

K. If manila rope becomes stiff and hard because of being wet, treat with a thin lubricating oil or warm petrolatum (a jelly-like petroleum-based dressing)

(NOTE: This can be accomplished by applying the lubricant with a paint brush.)

INFORMATION SHEET

X. Formulas for calculating safe working load (SWL) of different types and sizes of ropes (Assignment Sheet #2)

(NOTE: Each formula uses its own mathematical constant, a number assumed to have one value throughout the particular formula.)

A. Manila rope

1. Change diameter of rope to eighths
2. Square numerator and multiply by 20 (mathematical constant)

Example: $\frac{1}{2}$" manila rope = $\frac{4}{8}$" diameter

SWL = 4 x 4 x 20 = 320 lbs

B. Nylon rope and polyester rope

1. Change diameter of rope to eighths
2. Square numerator and multiply by 60 (mathematical constant)

Example: $\frac{5}{8}$" nylon or polyester rope = $\frac{5}{8}$" diameter

SWL = 5 x 5 x 60 = 1500 lbs

C. Polypropylene rope

1. Change diameter of rope to eighths
2. Square numerator and multiply by 40 (mathematical constant)

Example: $\frac{3}{4}$" polypropylene rope = $\frac{6}{8}$" diameter

SWL = 6 x 6 x 40 = 1440 lbs

D. Polyethylene rope

1. Change diameter of rope to eighths
2. Square numerator and multiply by 35 (mathematical constant)

Example: 1" polyethylene rope = $\frac{8}{8}$" diameter

SWL = 8 x 8 x 35 = 2240 lbs

INFORMATION SHEET

XI. Importance of spreading sling angles (Transparencies 2 and 3)

A. Changing angle of sling leg may increase the stress on the sling

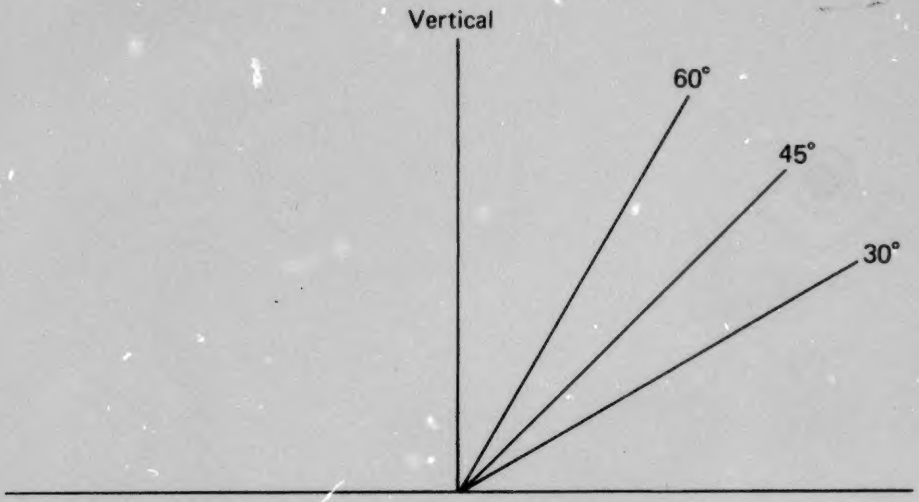
B. As the angle is reduced, lifting capacity is reduced very rapidly

C. When single leg of sling is at 60° angle, lifting capacity is only 87 percent of a vertical leg

D. When single leg of sling is at 45° angle, lifting capacity is 71 percent of that of a vertical leg

E. When single leg of sling is at 30° angle, lifting capacity is 50 percent of that of a vertical leg

Example:



INFORMATION SHEET

XII. Formula for calculating sling stress (Transparency 4; Assignment Sheet #3)

$$\frac{W \times L}{H \times N} = S$$

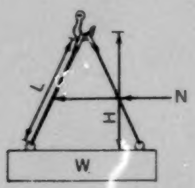
W = Weight of load

L = Length of sling

H = Height of load

N = Number of sling legs

Example:



W = 10
L = 6'
H = 4'
N = 2

$$\frac{10 \times 6}{2 \times 4} = \frac{60}{8} = 7\,1/2 \text{ tons}$$

Stress = 7 1/2 tons each sling

XIII. Hand signals used in rigging operations (Transparencies 5, 6, 7, 8, 9, and 10; Assignment Sheet #4)

(NOTE: Operators must become proficient in identifying and giving these hand signals.)

A. Hoist operation

   1. Hoist the load
   2. Lower the load
   3. Stop
   4. Emergency stop

B. Boom operation

   1. Hoist
   2. Lower
   3. Use main hoist
   4. Use whipline
   5. Raise boom
   6. Lower boom
   7. Move slowly

INFORMATION SHEET

8. Raise the boom and lower load
9. Lower the boom and raise the load
10. Swing
11. Stop
12. Emergency stop
13. Travel
14. Dog everything
15. Travel (both tracks)
16. Travel (one track)
17. Extend boom
18. Retract boom

C. Vehicle maneuvering

1. Move (forward or backward)
2. Turn while moving
3. Straighten out
4. Stop

XIV. Construction characteristics of wire rope used with heavy equipment

A. Size of wire in strand

B. Grade of steel wire used

C. Number of wires in each strand

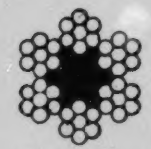
D. Number of strands

E. Type of core

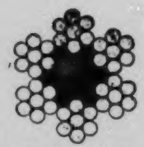
INFORMATION SHEET

F. Preformed lay

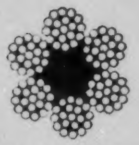
Examples:



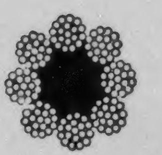
1. 6 x 7 coarse laid



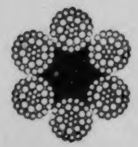
2. 6 x 19 Seale



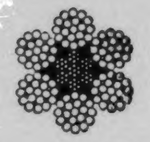
3. 6 x 19 modified Seale



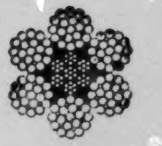
4. 8 x 19 modified Seale



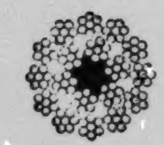
5. 6 x 37 extra pliable



6. 6 x 19 modified Seale with independent wire rope core, Lang-lay



7. 6 x 19 regular lay with independent wire rope center



8. 8 x 7 nonrotating

XV. Grades and strengths of steel used in wire rope

A. Iron wire–100,000 psi

B. Traction steel--180,000 to 190,000 psi

C. Mild plow steel--200,000 to 220,000 psi

D. Plow steel--220,000 to 240,000 psi

E. Improved plow steel--240,000 to 260,000 psi

XVI. Formula for calculating safe working loads (SWL) of different sizes of wire ropes (Assignment Sheet #5)

(NOTE: Compute in tons. The number 8 is a mathematical constant.)

Formula: Rope diameter x rope diameter x 8 = SWL (tons)

Example: $\frac{1}{2}$" diameter rope

$$\frac{1}{2} \times \frac{1}{2} \times 8 = 2 \text{ tons}$$

INFORMATION SHEET

XVII. Steps to take when performing maintenance on wire rope

(NOTE: Frequent application of proper lubricant to exterior of rope is necessary to help retain lubricant within the rope.)

A. Check for frayed and/or worn wires

B. Heat oil that is recommended by manufacturer

(NOTE: Apply oil while thin so that it will penetrate into the center of rope.)

C. Apply oil by moving rope through a long pan

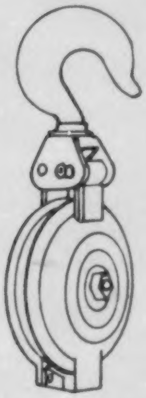
D. Wipe off surplus oil as rope leaves the pan

E. Let cool and thicken

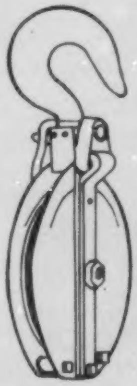
XVIII. Types of snatch blocks

(NOTE: Snatch blocks are used to increase the force exerted by a line when hoisting and dragging.)

A. Swivel hook

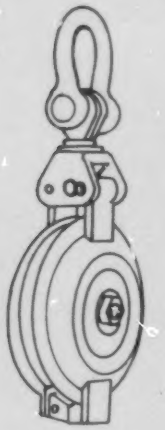


B. Self locking

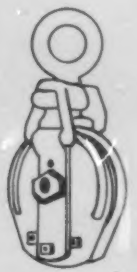


INFORMATION SHEET

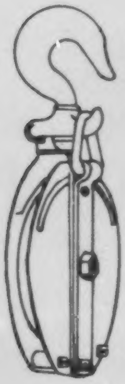
C. Swivel shackle



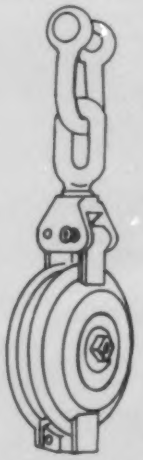
D. Swivel eye



E. Drop link



F. Upset swivel shackle



XIX. Types of cable fittings (Transparencies 11 and 12)

A. Standard solid thimble

B. Standard hawser thimble

C. Drop forged clip

D. Open wedge socket

E. Open socket for flat rope

F. Closed socket for flat rope

INFORMATION SHEET

G. Closed type bridge socket

H. Open type bridge socket

I. Swaged clevis fitting

J. Swaged round eye fitting

K. Swivel eye and socket

L. Screw pin shackle

M. Standard shackle

N. Turnbuckle with spliced rope

O. Turnbuckle with socketed rope

P. Turnbuckle with clipped rope

Q. Drop forged steel hook with thimble

R. Drop forged steel hook with shank

S. Drop forged steel hook with eye

T. Safety snap hook

U. Reversed eye hook

V. Drop forged steel swivel hook and socket

W. Logging swivel hook and socket with double swivel

X. Swivel eye socket with chain

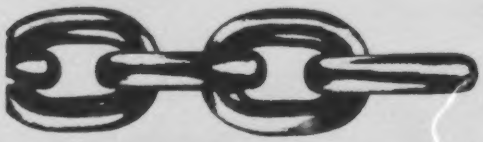
Y. Closed socket with chain

XX. Types of towing chains and accessories

(NOTE: Chain is made in a variety of sizes, strengths, and designs; size is designated by diameter of bar used to make links and ranges in size from 1/4" to 2".)

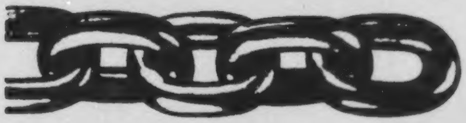
A. Chains

1. Proof chain

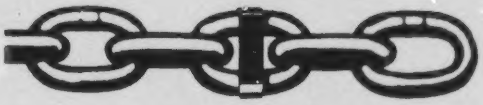


INFORMATION SHEET

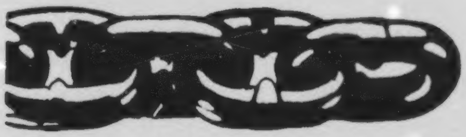
2. BBB chain



3. High test chain

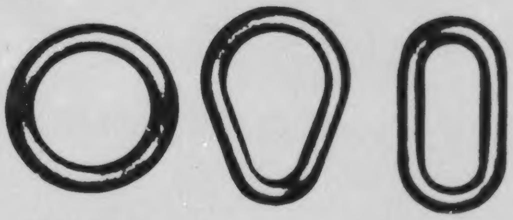


4. Alloy chain

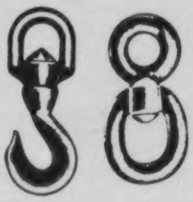


B. Accessories

1. Rings

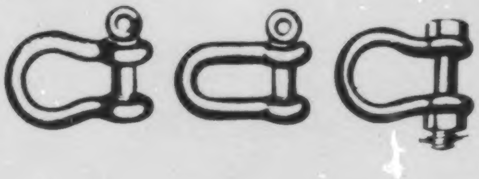


2. Swivels



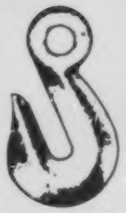
INFORMATION SHEET

3. Shackles

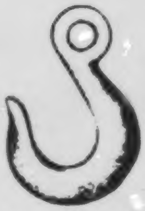


4. Hooks

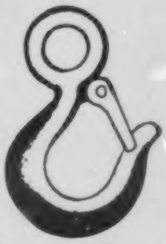
   a. Grab hook



   b. Slip hook



   c. Safety hook



INFORMATION SHEET

XXI. Good rigging practices (Assignment Sheet #6)

A. Turn hooks out

B. Use shackles on chokers where there may be cutting action

C. Pad all sharp corners and edges

D. Always make vertical lifts on eye bolts

(NOTE: Lifting at an angle reduces safe load as much as ninety percent [90%].)

E. Use thimble in eye splices

F. Use a shackle whenever two or more ropes are to be used over a hook

G. Use tag line to control loads

H. Secure all unused sling lines

I. Never wrap a rope around a hook

J. Do not permit bending of rope near a splice or attached fitting

K. Block all loads properly before unhooking

L. Never allow a shackle to be pulled at an angle

(NOTE: Use washers for packing if necessary.)

M. Do not use screw pin shackle if the pin can roll under load and unscrew

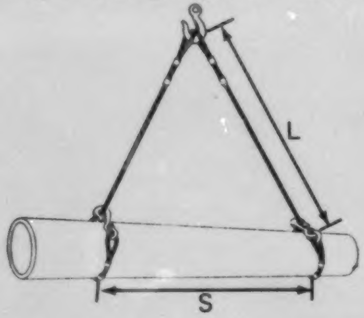
N. Center crane over load before lifting

O. Give all hand signals clearly and correctly

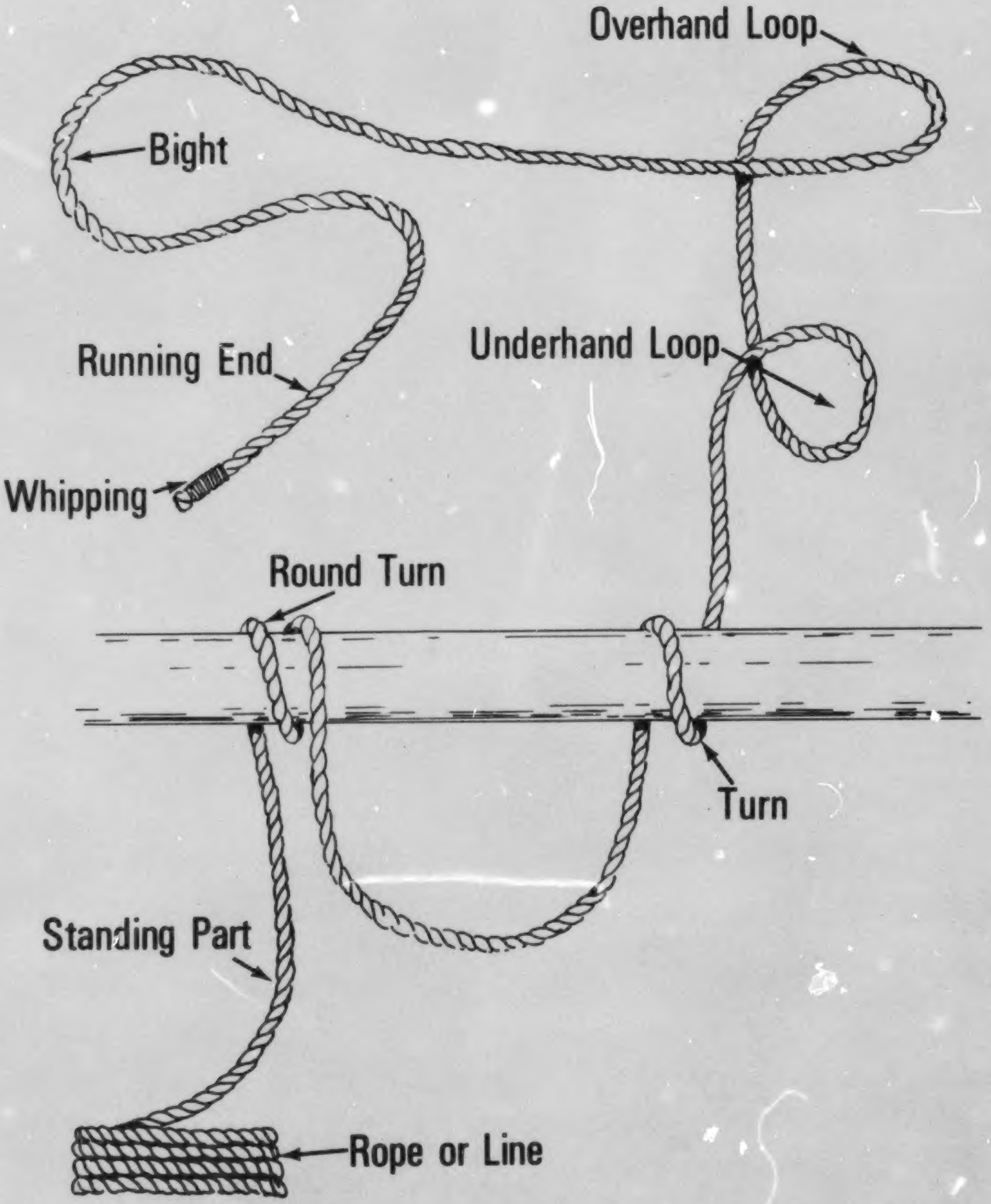
P. Keep machines at least ten feet (10') from all electrical equipment

Q. For proper sling angle, be sure length of slings is always greater than the span between the two connections for proper sling angle

Example: L (length of sling) is greater than S (span)



Elements of Knots, Bends, and Hitches


Overhand Loop
Bight
Running End
Underhand Loop
Whipping
Round Turn
Turn
Standing Part
Rope or Line

Sling Angle and Load Factors

Sling Angle	Load Angle Factor
0 (Vertical)	1.000
15°	1.035
20°	1.064
25°	1.104
30°	1.155
35°	1.221
40°	1.305
45°	1.414
50°	1.555
55°	1.742
60°	2.000

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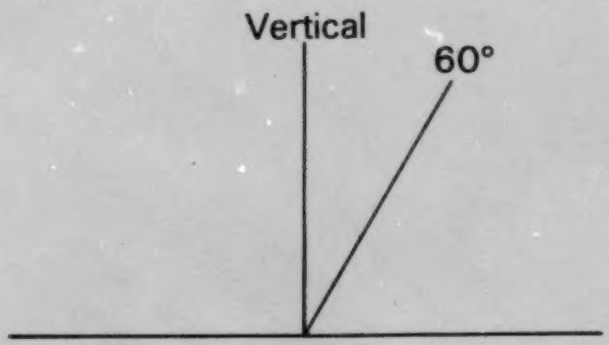
Sling Angles

Critical Angle--Sling Angle that Exists when the Tension in the Sling Leg Equals the Weight of the Load

Critical Angle Formula

$$CA = \frac{60^\circ}{N}$$



N = Number of Sling Legs

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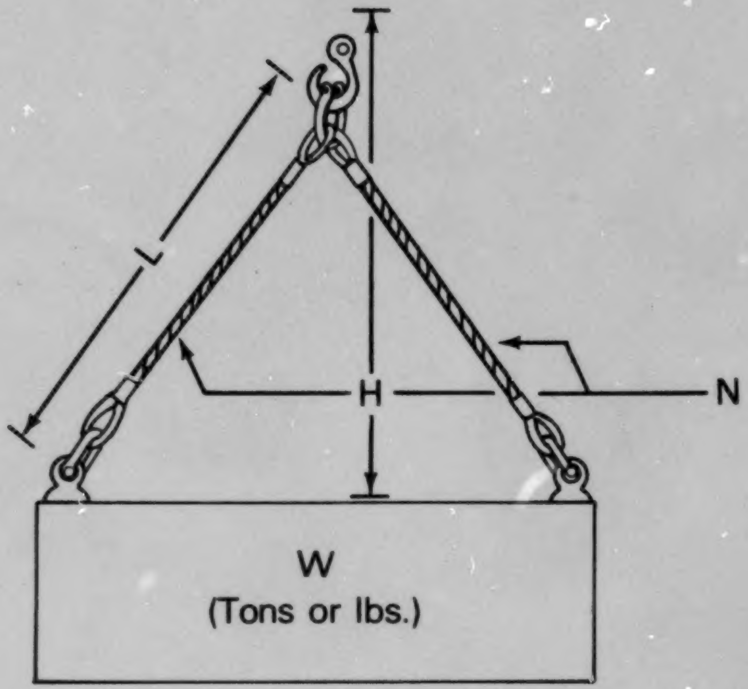
Formula for Calculating Sling Stress



$$S = \frac{W \times L}{H \times N}$$

$$S = \frac{10 \times 6}{2 \times 4}$$

$$S = \frac{60}{8}$$

$S = 7\frac{1}{2}$ Tons

W=10 Weight

L=6′ Length

H=4′ Height

N=2 No. of Sling Legs

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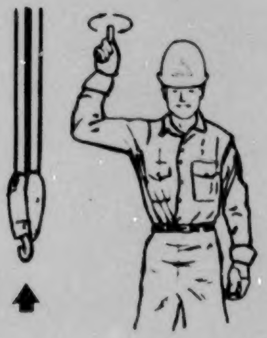
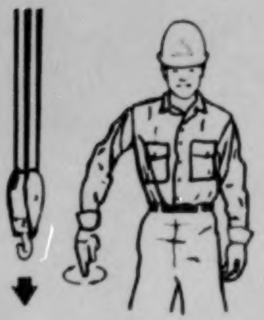
Hoist Signals

Hoist the Load



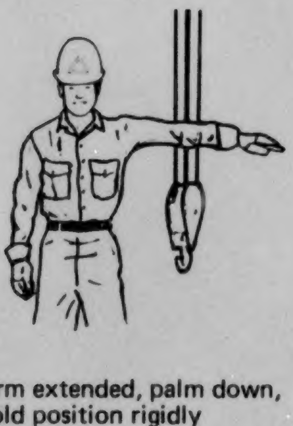
Forearm vertical, forefinger pointing up, move hand in small, horizontal circle

Lower the Load



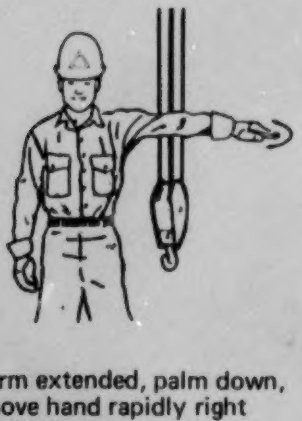
Arm extended downward, forefinger pointing down, move hand in small, horizontal circle

Stop



Arm extended, palm down, hold position rigidly

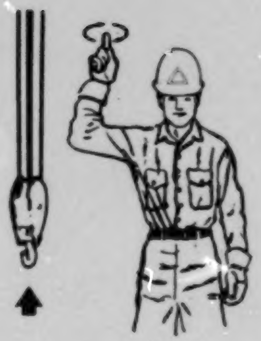
Emergency Stop



Arm extended, palm down, move hand rapidly right and left

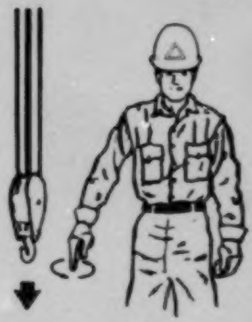
Standard Hand Signals for Boom Operation

Hoist



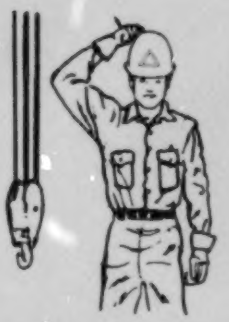
Forearm vertical, forefinger pointing up, move hand in small, horizontal circle

Lower



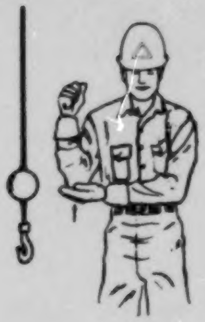
Arm extended downward, forefinger pointing down, move hand in small horizontal circles

Use Main Hoist



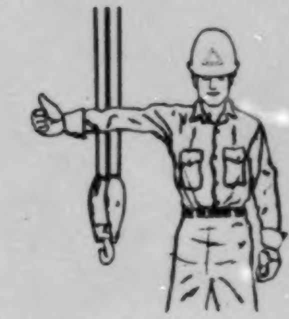
Tap fist on head then use regular signals

Use Whipline



Tap elbow with one hand: then use regular signals

Raise Boom

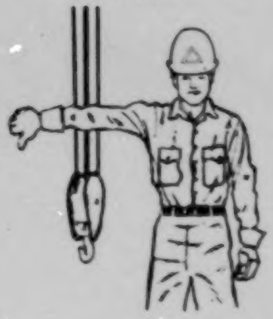


Arm extended, fingers closed, thumb pointing upward

Standard Hand Signals for Boom Operation

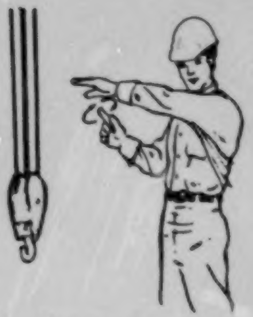
(Continued)

Lower Boom



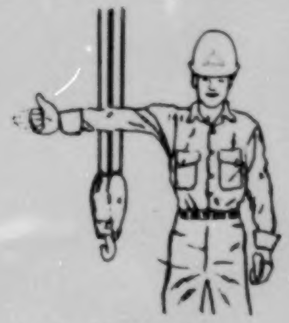
Arm extended, fingers closed, thumb pointing downward

Move Slowly



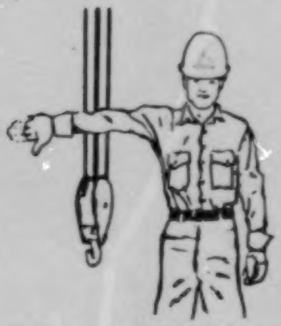
Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (hoist slowly shown as example)

Raise the Boom and Lower the Load



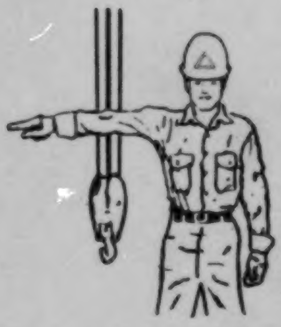
Arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired

Lower the Boom and Raise the Load



Arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired

Swing

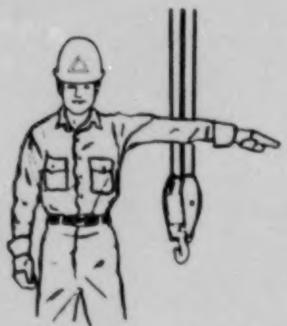


Arm extended, point with finger in direction of swing of boom

Standard Hand Signals for Boom Operation

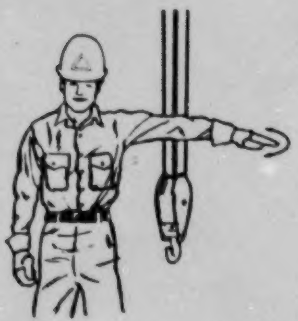
(Continued)

Stop



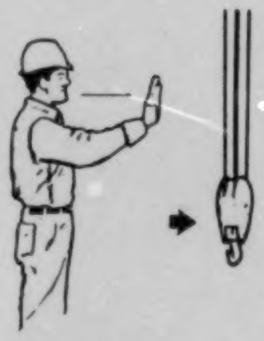
Arm extended, palm down hold position rigidly

Emergency Stop



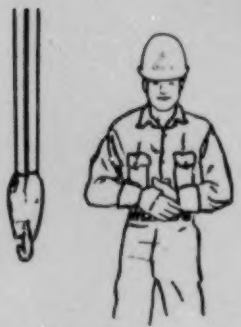
Arm extended, palm down, move hand rapidly right and left

Travel



Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel

Dog Everything

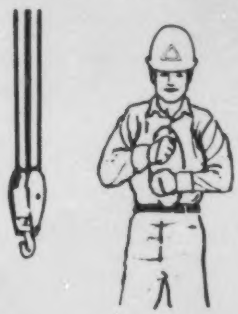


Clasp hands in front of body

Standard Hand Signals for Boom Operation

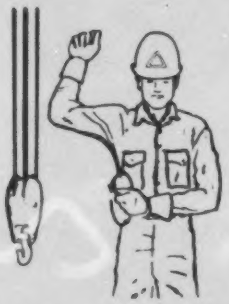
(Continued)

Travel (both tracks)



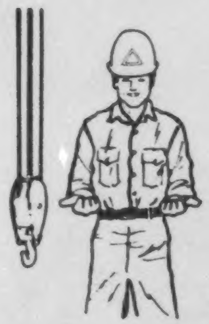
Use both fists in front of body, making a circular motion about each other indicating direction of travel: forward or backward (crawler cranes only)

Travel (one track)



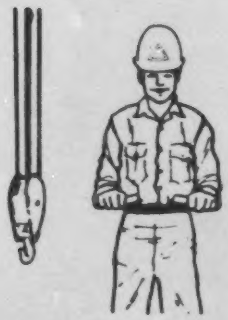
Lock the track on side indicated by raised fist, travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body (for crawler cranes only)

Extend Boom



Both fists in front of body with thumbs pointing outward

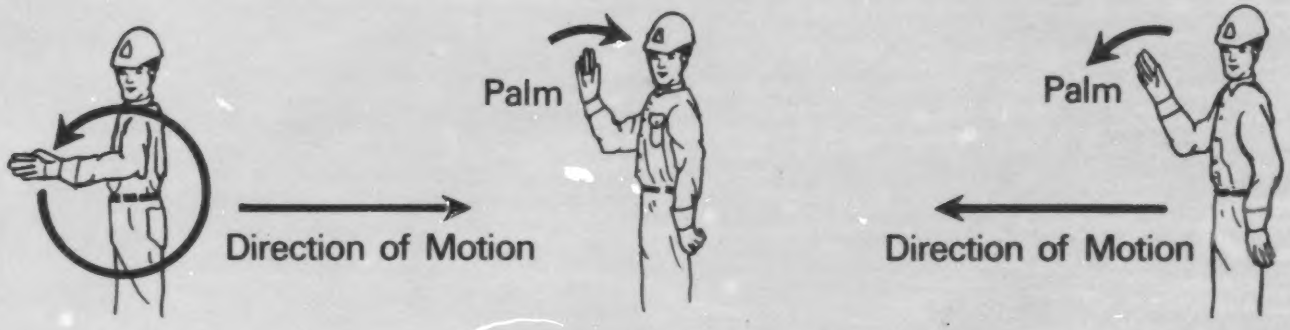
Retract Boom



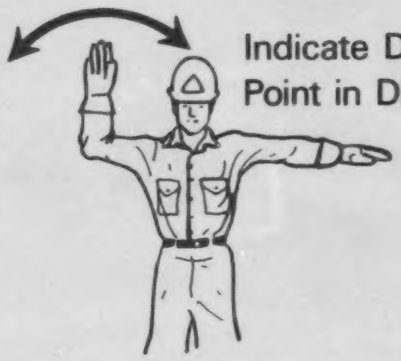
Both fists in front of body with thumbs pointing toward each other

Maneuvering Vehicles

Move

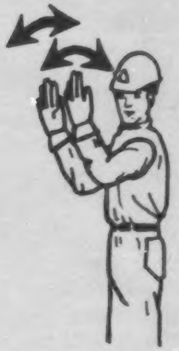

Palm
Palm
Direction of Motion
Direction of Motion

Turn While Moving

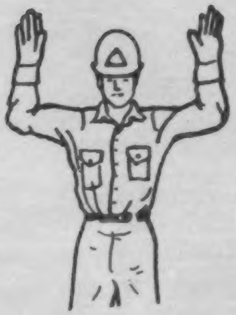


Indicate Direction
Point in Direction of Turn

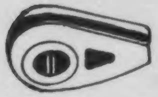
Straighten Out

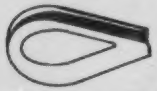


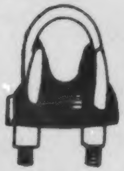
Stop

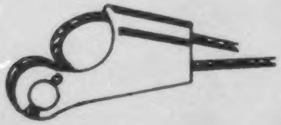


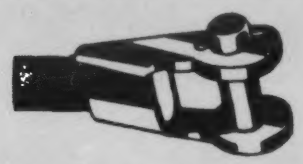
Wire Rope Fittings

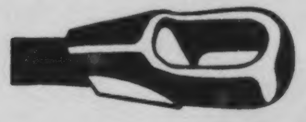

Standard Solid Thimble

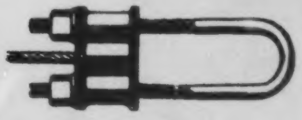

Standard Hawser Thimble

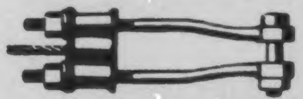

Drop Forged Clip

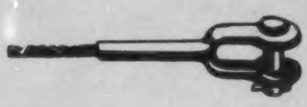

Open Wedge Socket

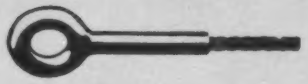

Open Socket for Flat Rope

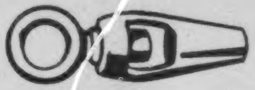

Closed Socket for Flat Rope

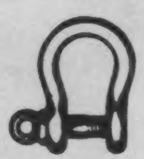

Closed-type Bridge Socket


Open-type Bridge Socket


Swaged Clevis Fitting


Swaged Round Eye Fitting

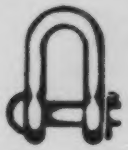

Swivel Eye and Socket


Screw Pin Shackle

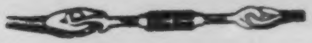
Wire Rope Fittings

(Continued)

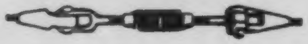
Standard Shackle



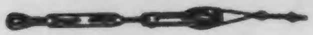
Turnbuckle with Spliced Rope



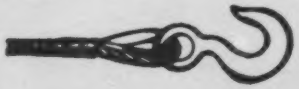
Turnbuckle with Socketed Rope



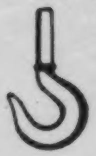
Turnbuckle with Clipped Rope



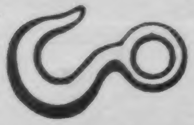
Drop Forged Steel Hook with Thimble



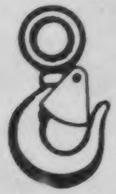
Drop Forged Steel Hook with Shank



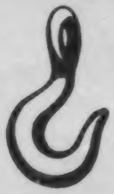
Drop Forged Steel Hook with Eye



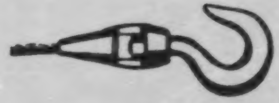
Safety Snap Hook



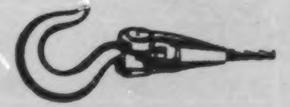
Reversed Eye Hook



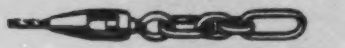
Drop Forged Steel Swivel Hook and Socket



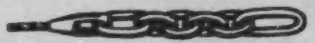
Logging Swivel Hook and Socket with Double Swivel



Swivel Eye Socket with Chain



Closed Socket with Chain



RIGGING
UNIT III

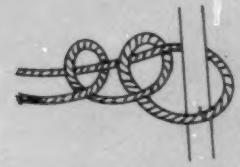
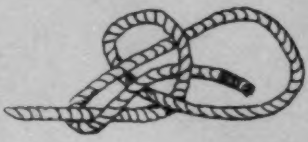
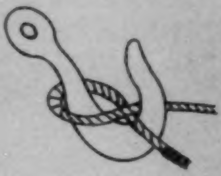
ASSIGNMENT SHEET #1-DISTINGUISH AMONG TYPES OF KNOTS

NAME ______________________________ SCORE ______________

A good knot should be easy to tie, should hold without slipping, and should be easy to untie. These particular knots were chosen because of the jobs for which they will be used.

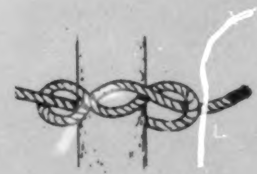
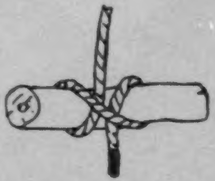
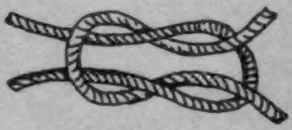
Distinguish among types of knots by writing an "X" in the blanks under the correct illustrations.

1. Bowline

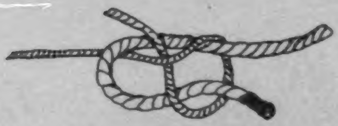
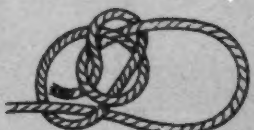
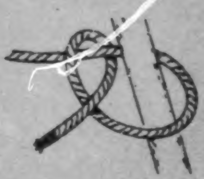
a. ______________ b. ______________ c. ______________

2. Square knot

a. ______________ b. ______________ c. ______________

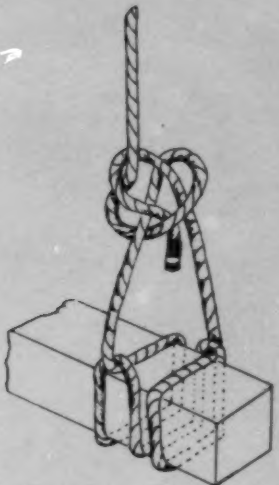
3. Sheet bend

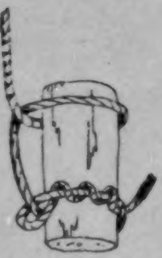




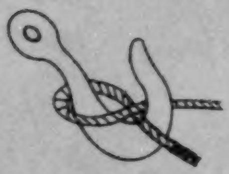
a. ______________ b. ______________ c. ______________

ASSIGNMENT SHEET #1

4. Timber hitch with half hitch







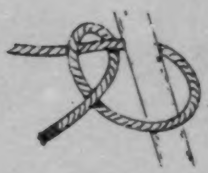
a. ________________ b. ________________ c. ________________

Write an "X" in the correct blanks.

5. _____a. Timber hitch

_____b. Black wall hitch

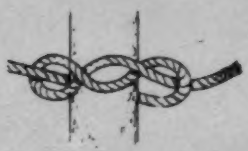
_____c. Half hitch



6. _____a. Clove hitch

_____b. Timber hitch

_____c. Square knot

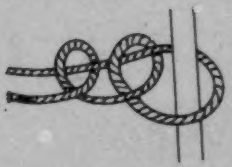


ASSIGNMENT SHEET #1

7. ______a. Two half hitches

______b. Sheet bend

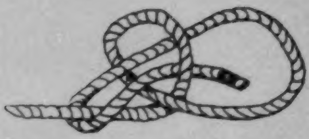
______c. Scaffold hitch



8. ______a. Square knot

______b. Bowline

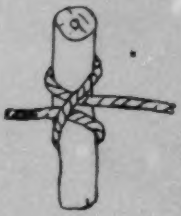
______c. Clove hitch



9. ______a. Timber hitch with half hitch

______b. Clove hitch

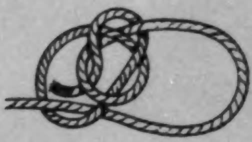
______c. Blackwall hitch



10. ______a. Bowline

______b. Half hitch

______c. Running bowline



RIGGING
UNIT III

ASSIGNMENT SHEET #2--CALCULATE SAFE WORKING LOAD (SWL) OF DIFFERENT TYPES AND SIZES OF ROPES

NAME ______________________________ SCORE ______________

Calculate safe working load (SWL) of different types and sizes of ropes. Use your Information Sheet for reference.

Mathematical constants:

20 - Manila
35 - Polyethylene
40 - Polypropylene
60 - Nylon and polyester

Example: $\frac{1}{2}''$ manila rope = $\frac{4}{8}''$

SWL = 4 x 4 x 20 = 320 lbs

1. 1" manila rope

   SWL = ______________

2. $1\frac{1}{2}''$ manila rope

   SWL = ______________

3. $\frac{3}{8}''$ nylon rope

   SWL = ______________

4. $\frac{7}{8}''$ polyester rope

   SWL = ______________

ASSIGNMENT SHEET #2

5. $\frac{1}{2}$" polypropylene rope

SWL = ______________

6. $\frac{7}{8}$" polypropylene rope

SWL = ______________

7. $\frac{3}{4}$" polypropylene rope

SWL = ______________

8. $\frac{5}{8}$" manila rope

SWL = ______________

9. $1\frac{1}{4}$" nylon rope

SWL = ______________

10. 1" polyethylene rope

SWL = ______________

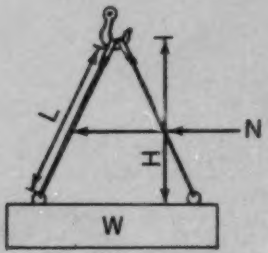
RIGGING
UNIT III

ASSIGNMENT SHEET #3--CALCULATE SLING STRESS

NAME ______________________________ SCORE ______________

Calculate sling stress for the following illustrations.

Example:

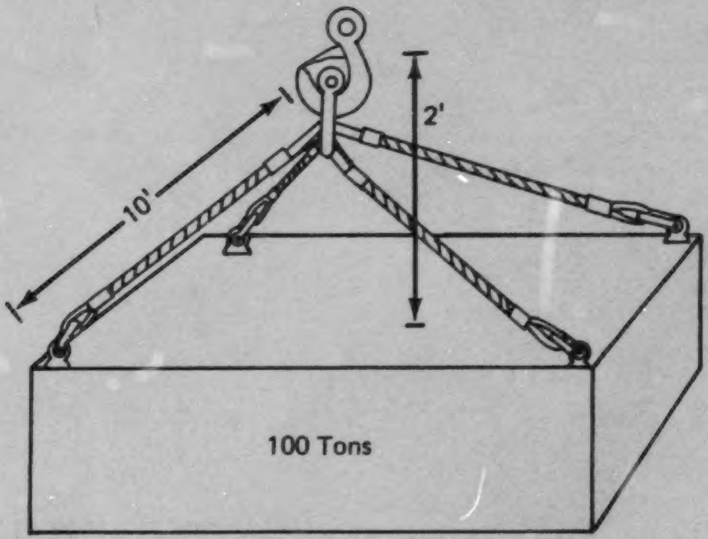


W = 10
L = 3
H = 2
N = 2

$$\frac{10 \times 3}{2 \times 2} = \frac{30}{4} = 7\ 1/2$$

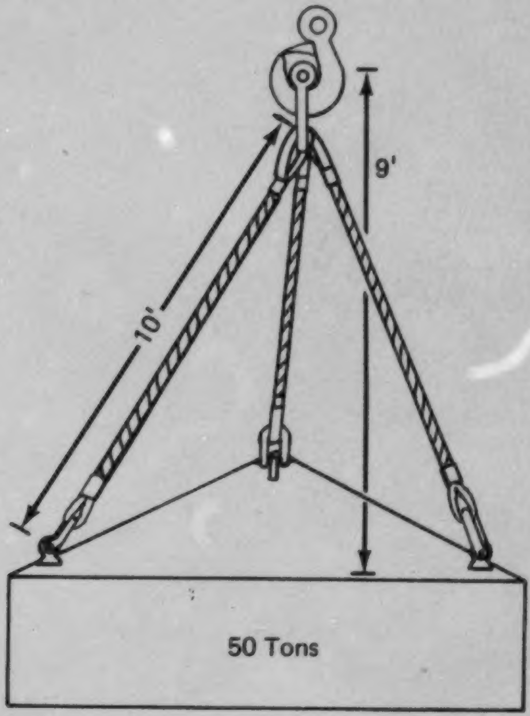
Stress = 7 1/2 tons each sling

1. Sling stress = ______________



ASSIGNMENT SHEET #3

2. Sling stress = ____________________



RIGGING
UNIT III

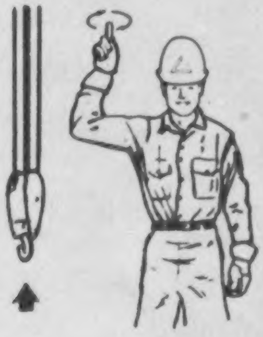
ASSIGNMENT SHEET #4--DISTINGUISH AMONG HAND SIGNALS USED IN RIGGING OPERATIONS

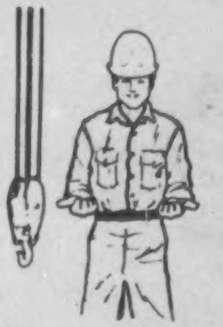
NAME ______________________________ SCORE ______________

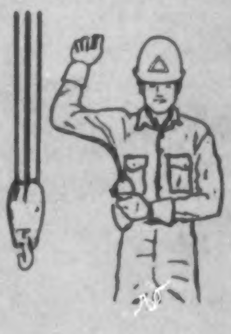
In heavy equipment operations it is very important to know how to use hand signals; by knowing them you may be able to help another worker get out of a bad situation and possibly avoid a serious accident.

Distinguish among hand signals by writing an "X" under the correct illustrations.

1. Hoist the load

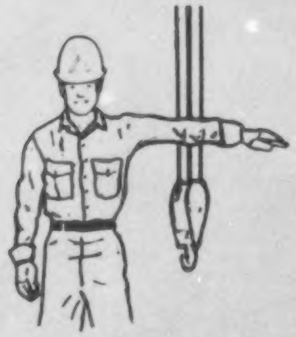


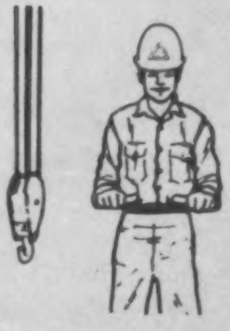


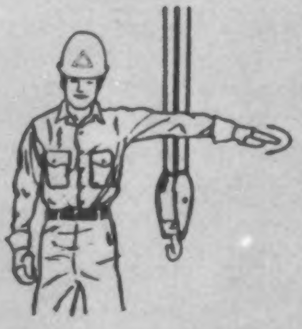


a. ______________ b. ______________ c. ______________

2. Emergency stop



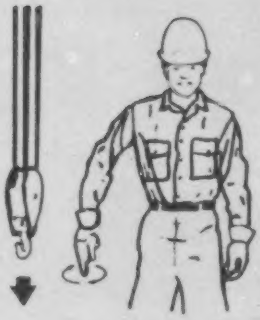


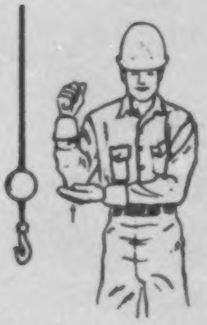


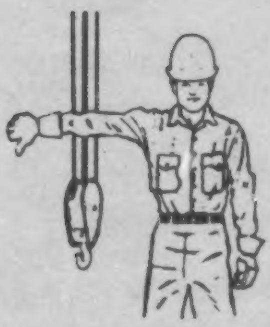
a. ______________ b. ______________ c. ______________

ASSIGNMENT SHEET #4

3. Lower the boom

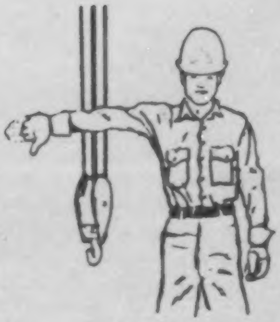


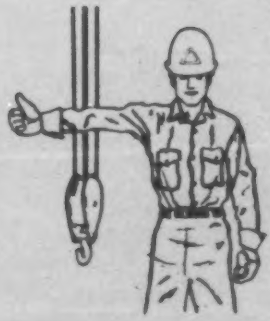


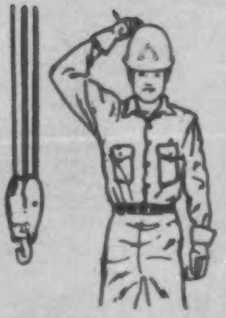


a. ____________ b. ____________ c. ____________

4. Lower the boom and raise the load



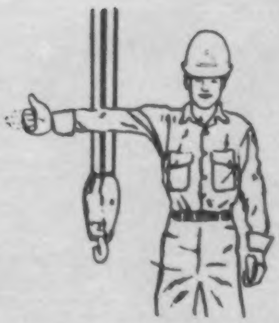


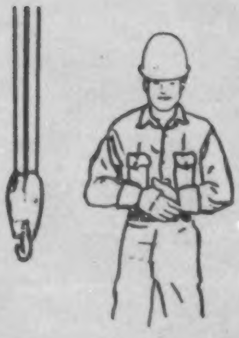


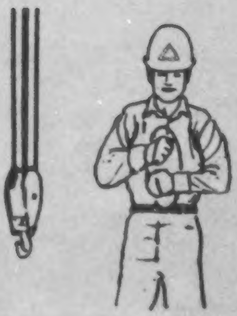
a. ____________ b. ____________ c. ____________

ASSIGNMENT SHEET #4

5. Dog everything

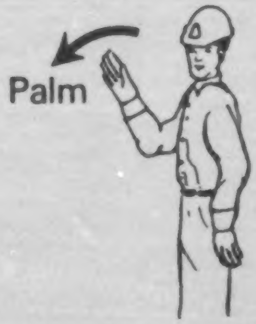


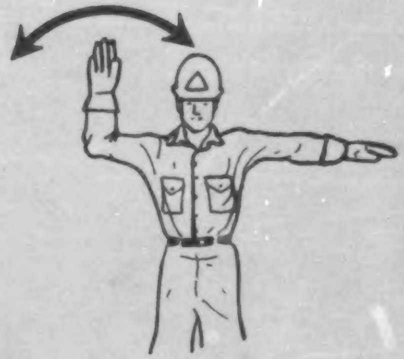


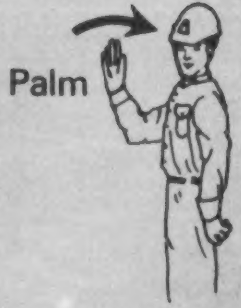


a. ______________ b. ______________ c. ______________

6. Turn while moving







a. ______________ b. ______________ c. ______________

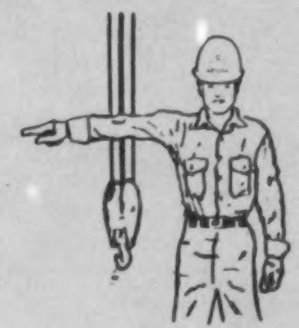
ASSIGNMENT SHEET #4

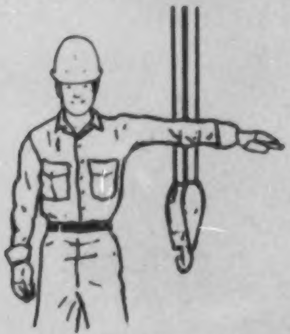
Write an "X" in the correct blanks.

7. ______a. Turn while moving

______b. Swing

______c. Move in this direction





8. ______a. Move in this direction

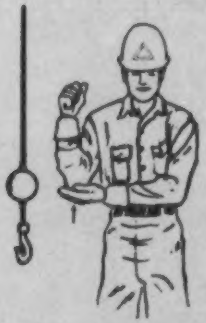
______b. Stop

______c. Raise the boom

9. ______a. Emergency stop

______b. Rehaul or retract

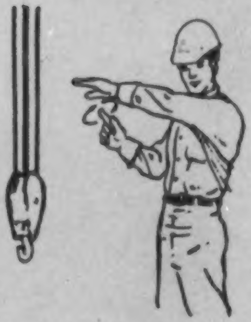
______c. Use whipline



10. ______a. Lower the boom and hold the load

______b. Lower the boom and raise the load

______c. Move slowly

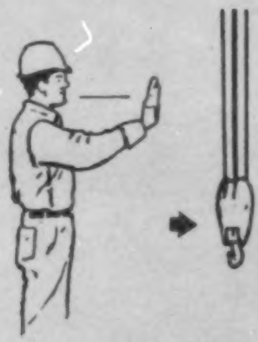


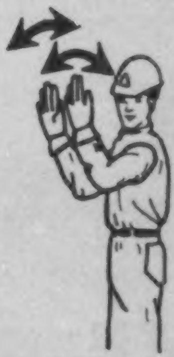
ASSIGNMENT SHEET #4

11. ______a. Lower the load

______b. Lower the boom

______c. Travel





12. ______a. Stop

______b. Straighten out

______c. Turn while moving

RIGGING
UNIT III

ASSIGNMENT SHEET #5–CALCULATE SAFE WORKING LOAD (SWL) OF DIFFERENT SIZES OF WIRE ROPES

NAME ______________________________ SCORE __________

Calculate safe working load (SWL) of different sizes of wire ropes. Use your Information Sheet for reference. Round all answers to nearest whole number.

Example: $\frac{1}{2}''$ diameter rope

$\frac{1}{2}'' \times \frac{1}{2}'' \times 8 = 2$ tons

1. $\frac{5}{8}''$ diameter rope

SWL = __________

2. $\frac{7}{8}''$ diameter rope

SWL = __________

3. 1" diameter rope

SWL = __________

4. $1\frac{1}{8}''$ diameter rope

SWL = __________

5. $1\frac{1}{2}''$ diameter rope

SWL = __________

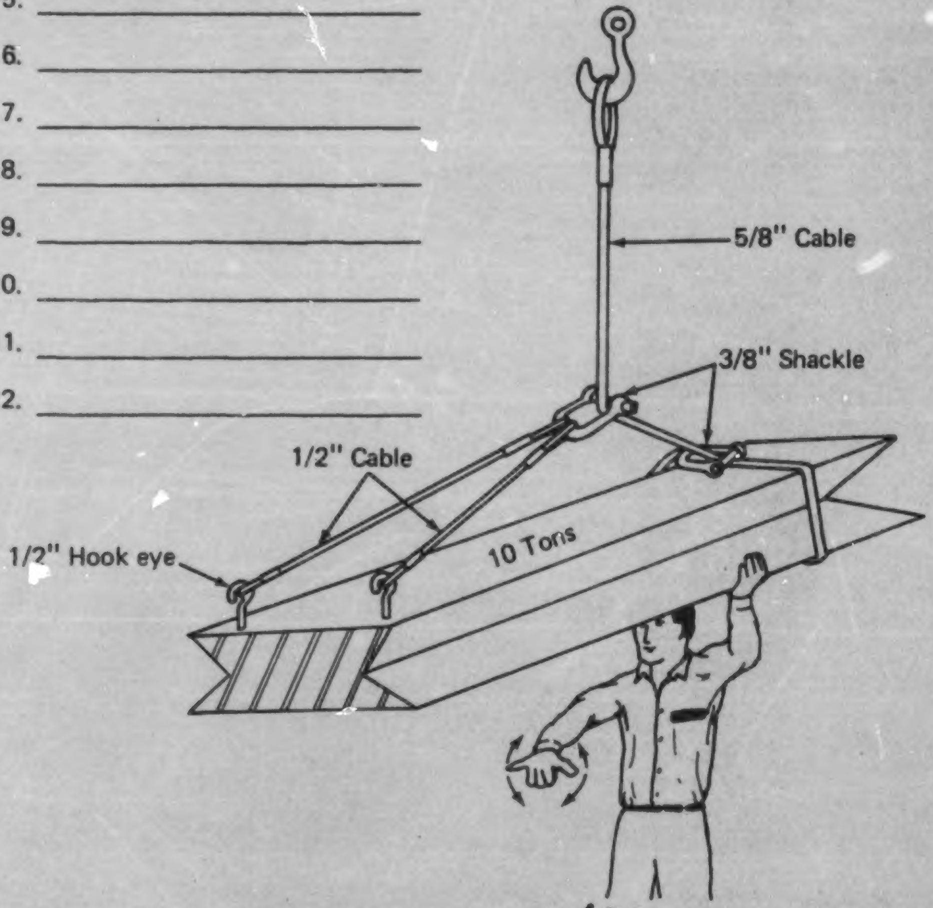
RIGGING
UNIT III

ASSIGNMENT SHEET #6–IDENTIFY BAD RIGGING PRACTICES

NAME____ SCORE ____________

Using the illustration below, write down as many bad rigging practices as you can find. Also list any safety tips that are not observed in the drawing.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________
9. ______________________________
10. ______________________________
11. ______________________________
12. ______________________________


5/8" Cable
3/8" Shackle
1/2" Cable
1/2" Hook eye
10 Tons

RIGGING
UNIT III

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. b
2. c
3. a
4. b
5. c
6. b
7. a
8. b
9. b
10. c

Assignment Sheet #2

1. 1280 lbs
2. 2880 lbs
3. 540 lbs
4. 2940 lbs
5. 640 lbs
6. 1960 lbs
7. 1440 lbs
8. 500 lbs
9. 6000 lbs
10. 2240 lbs

Assignment Sheet #3

1. 125 tons each sling
2. $18\frac{1}{2}$ tons each sling

Assignment Sheet #4

1. a
2. c
3. c
4. a
5. b
6. b
7. b
8. b
9. c
10. c
11. c
12. b

Assignment Sheet #5

1. 3 tons
2. 6 tons
3. 8 tons
4. 10 tons
5. 18 tons

Assignment Sheet #6

1. Incorrect hand signals
2. Operator cannot see hand signals
3. Hand is on load
4. Person is under load
5. No tagline
6. Load is not balanced
7. No padding on sharp edges
8. No safety latch on hook block
9. Hook eyes too small and not in far enough
10. Sling angle too small
11. All sling cables too small
12. Shackles too small

RIGGING
UNIT III

JOB SHEET #1--TIE KNOTS

I. Materials

   A. Two pieces of equal-sized rope

   B. One piece of different-sized rope

   C. One piece timber or pole

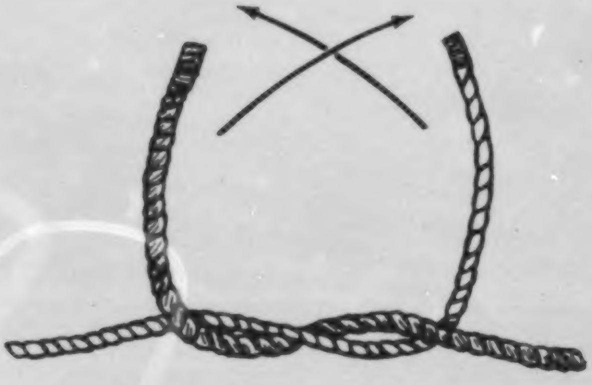
II. Procedure

   A. Square knot

   (NOTE: When tying a square knot it is good to remember left-over-right and right-over-left.)

   1. Use two pieces of equal-sized rope
   2. Grasp one piece of rope in each hand about eight inches from end
   3. Cross left end over right end (Figure 1)

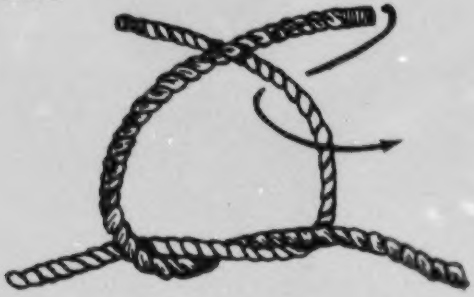
FIGURE 1



JOB SHEET #1

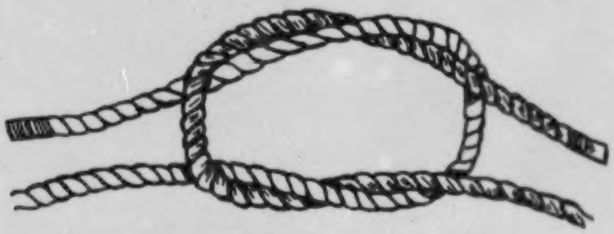
4. Cross right end over left end (Figure 2)

FIGURE 2



5. Pull the knot snug (Figure 3)

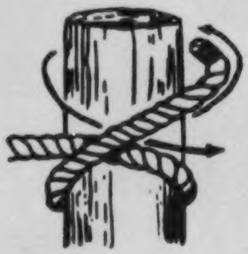
FIGURE 3



B. Clove hitch

1. Grasp one piece of rope and make one turn around a piece of timber
2. Cross the end over the standing part (Figure 4)

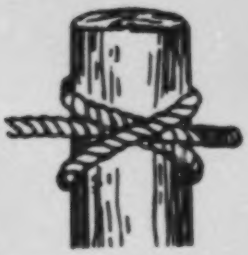
FIGURE 4



JOB SHEET #1

3. Take another turn around timber, and this time bring the end under the standing part
4. Pull the knot snug (Figure 5)

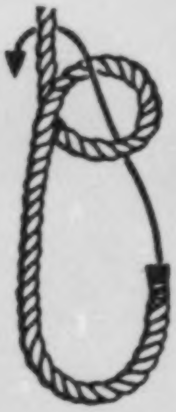
FIGURE 5



C. Bowline

1. Form an underhand loop several inches from end of rope
2. Pull rope end up through the loop from the back, leaving desired loop size (Figure 6)

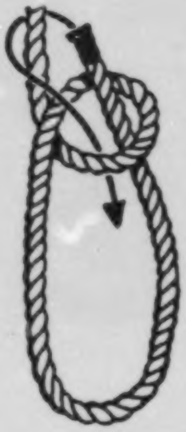
FIGURE 6



JOB SHEET #1

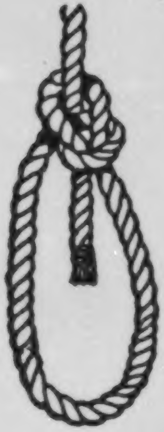
3. Twist rope end around the standing part and back through the loop (Figure 7)

FIGURE 7



4. Pull the knot snug (Figure 8)

FIGURE 8

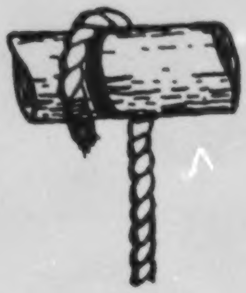


JOB SHEET #1

D. Half hitch

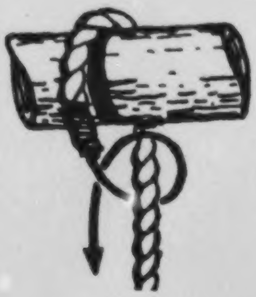
1. Make a turn over a piece of timber (Figure 9)

FIGURE 9



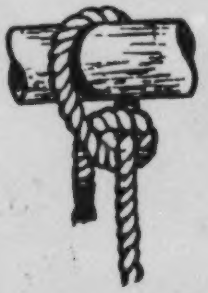
2. Make a turn around and over the standing part and back through the loop that was formed (Figure 10)

FIGURE 10



3. Pull knot snug (Figure 11)

FIGURE 11

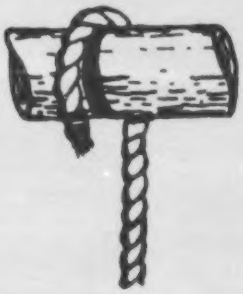


JOB SHEET #1

E. Two half hitches

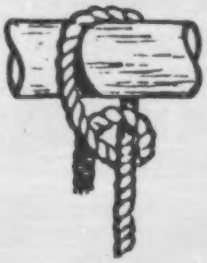
1. Make a turn over a piece of timber (Figure 12)

FIGURE 12



2. Make a turn around and over the standing part and back through the loop that was formed (Figure 13)

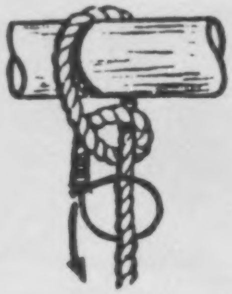
FIGURE 13



JOB SHEET #1

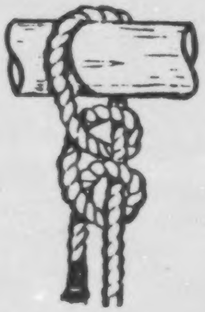
3. Make another turn around the standing part and back through the loop that was formed (Figure 14)

FIGURE 14



4. Pull knot snug (Figure 15)

FIGURE 15

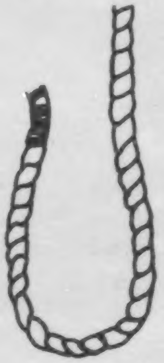


(NOTE: If the two hitches are slid together along the standing part to form a single knot, the knot becomes a clove hitch.)

F. Sheet bend

1. Form a loop on the end of one rope (Figure 16)

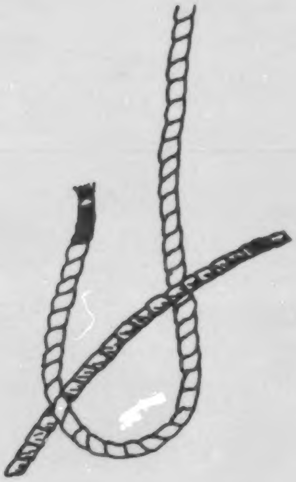
FIGURE 16



JOB SHEET #1

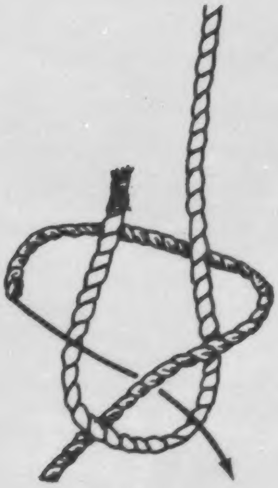
2. Lay second rope through the loop (Figure 17)

FIGURE 17



3. Twist end of second rope around standing part and running end of first rope (Figure 18)

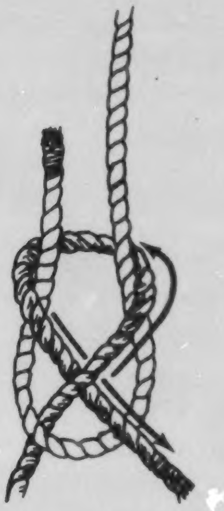
FIGURE 18



JOB SHEET #1

4. Continue bringing second rope around first rope; then run the end under standing part of itself and over first rope (Figure 19)

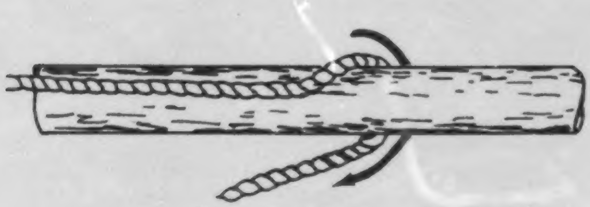
FIGURE 19



G. Timber hitch with half hitch

1. Lay rope lengthwise on timber; then make a turn over and around the piece of timber (Figure 20)

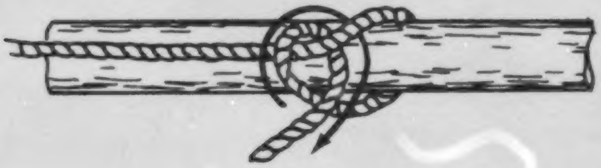
FIGURE 20



JOB SHEET #1

2. Place rope over and then under itself forming loop (Figure 21)

FIGURE 21



3. Wrap end back around itself two or three times (Figures 22 and 23)

FIGURE 22

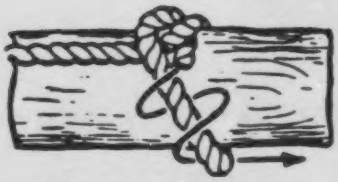
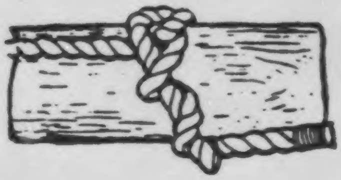


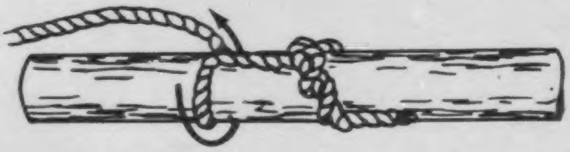
FIGURE 23



4. Pull rope so that it is snug

5. Pick up left end of rope, and make a loop under and around timber several inches from timber hitch (Figure 24)

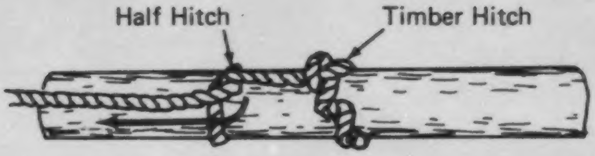
FIGURE 24



JOB SHEET #1

6. Loop this end of rope under itself, and then pull snugly to the left (Figure 25)

FIGURE 25


Half Hitch
Timber Hitch

RIGGING
UNIT III

JOB SHEET #2--INSTALL WIRE ROPE CLIPS

I. Tools and equipment

- A. Length of wire rope
- B. Clips, 3
- C. Thimble
- D. Wrench (to fit nuts on clips)

II. Procedure

- A. Turn back a length of rope beyond pointed end of thimble equal to the number of clips times clip spacing (Figures 1 and 2)

FIGURE 1

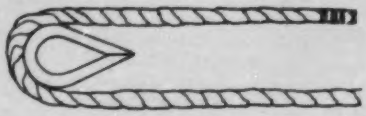
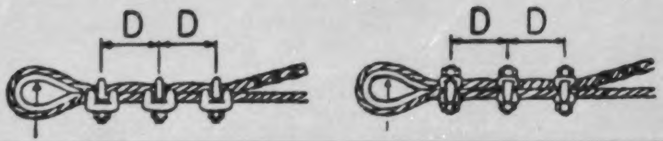


FIGURE 2



	U-BOLT CLIP		FIST GRIP CLIP	
Diameter of Wire Rope Inches	Number of Clips for Improved Plow Steel	Minimum Spacing D between Clips Inches	Number of Clips for Improved Plow Steel	Minimum Spacing D between Clips Inches
3/8	3	3 1/4	3	3 1/4
1/2	4	3 3/4	3	3 3/4
5/8	4	4	3	4
3/4	5	4 1/2	4	4 1/2
7/8	5	5 1/4	4	5 1/4
1	5	6	5	6
1 1/8	6	6 3/4	5	6 3/4
1 1/4	6	7 1/2	6	7 1/2
1 3/8	7	8 1/4	6	8 1/4
1 1/2	7	9	6	9

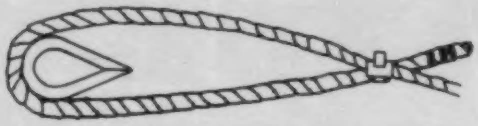
(NOTE: Number and spacing of clips shown in table are minimum number required to develop 80% of full strength of the rope.)

From *Handbook for Riggers* with permission of W. G. (Bill) Newberry

JOB SHEET #2

B. Position first clip at least one clip base width from end of wire rope (Figure 3)

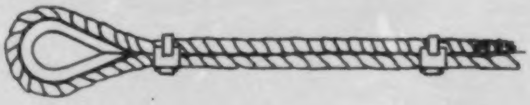
FIGURE 3



C. Tighten nuts, alternating from one to the other to obtain equal clamping action

D. Position second clip next to end of thimble and tighten nuts until firm but not tight (Figure 4)

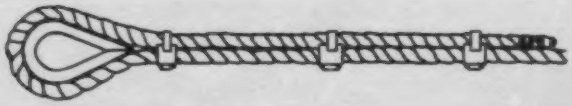
FIGURE 4



E. Space the third clip equally between the first two and tighten nuts until firm

F. Take up any rope slack; then alternately tighten nuts on each clip until they are tight (Figure 5)

FIGURE 5



RIGGING
UNIT III

JOB SHEET #3–RIG AND HANDLE DIFFERENT TYPES OF LOADS

I. Equipment

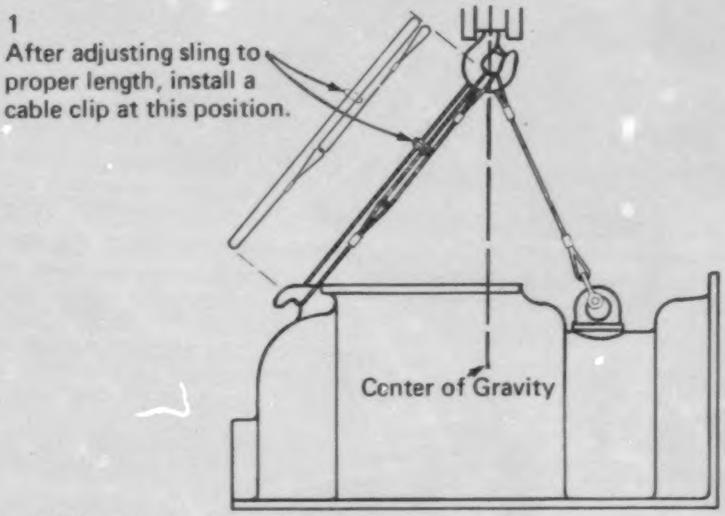
- A. Hoist
- B. Load
- C. Slings
- D. Spreader bar

II. Procedure for load where center of gravity is non-centered

(CAUTION: For loads that appear to be extremely heavy, the exact weight of load must be determined prior to rigging to assure that load will not exceed lifting capacity of hoist or exceed safe working load of wire rope used.)

- A. Estimate location of center of gravity
- B. Spot hook over this point
- C. Attach slings of proper strength and length from hook to lifting lugs (Figure 1)

FIGURE 1


After adjusting sling to proper length, install a cable clip at this position.
Center of Gravity

Used with permission of Mc-Graw-Hill Book Company

(NOTE: Slings of different lengths will probably have to be used. Because they are not always available, it may be necessary to improvise.)

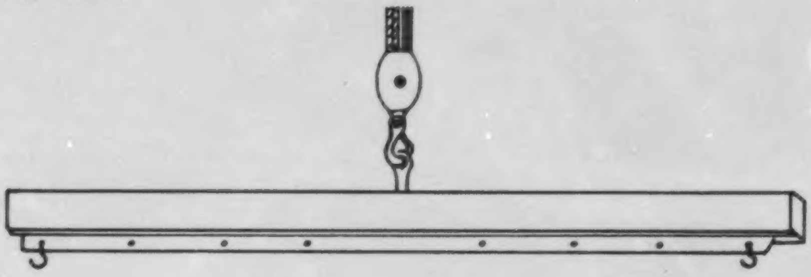
(CAUTION: Be very careful that proper slings are used and that they are attached properly. Use wire rope clips if necessary.)

JOB SHEET #3

III. Procedure for rigging extra long loads

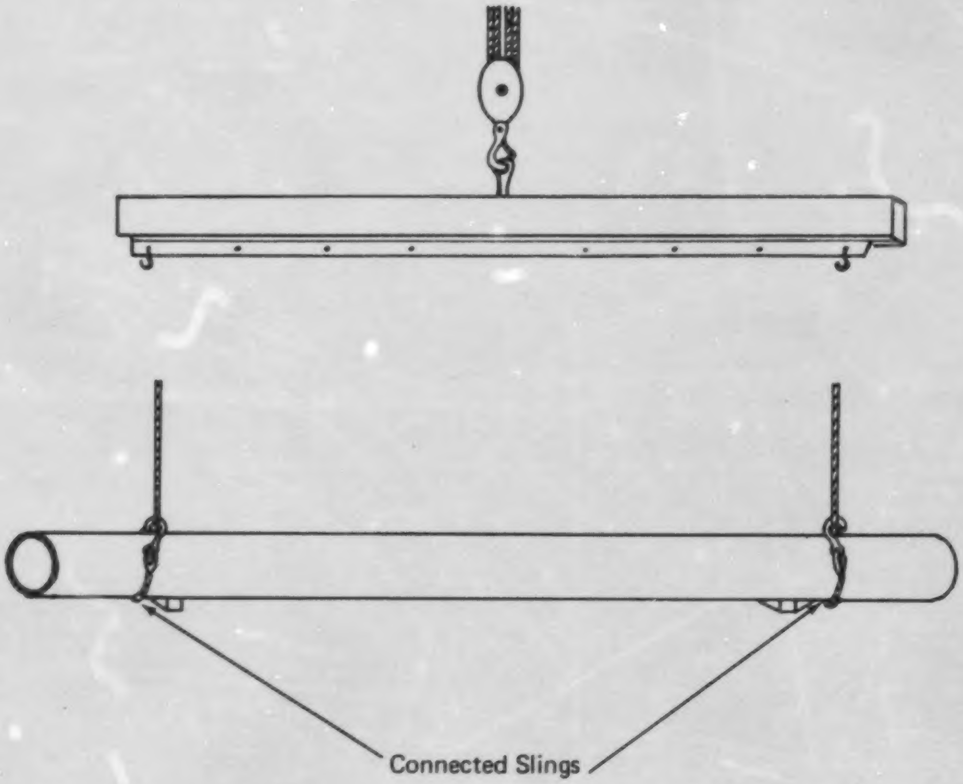
A. Attach spreader bar to hoist hook (Figure 2)

FIGURE 2



B. Center spreader bar over load; then connect sling to each end of load (Figure 3)

FIGURE 3

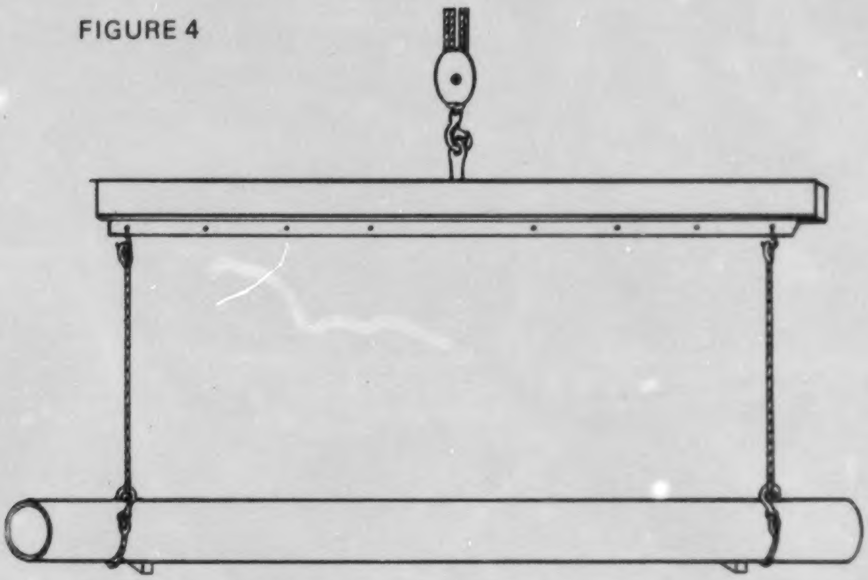


JOB SHEET #3

C. Connect long end of slings to spreader bar (Figure 4)

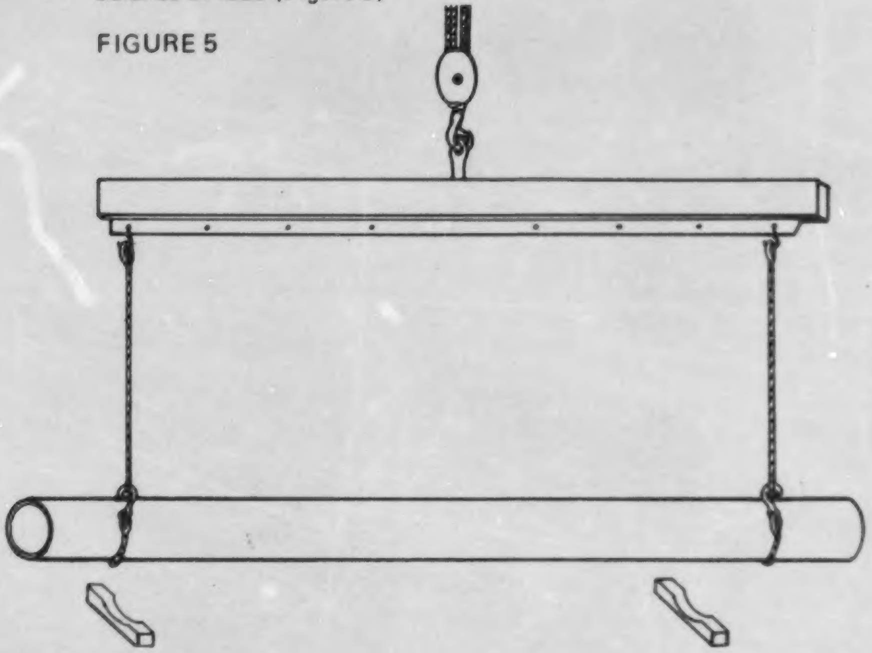
(NOTE: Be sure that hooks face out.)

FIGURE 4



D. Take up strain on line by lifting just a few inches off ground to check balance of load (Figure 5)

FIGURE 5



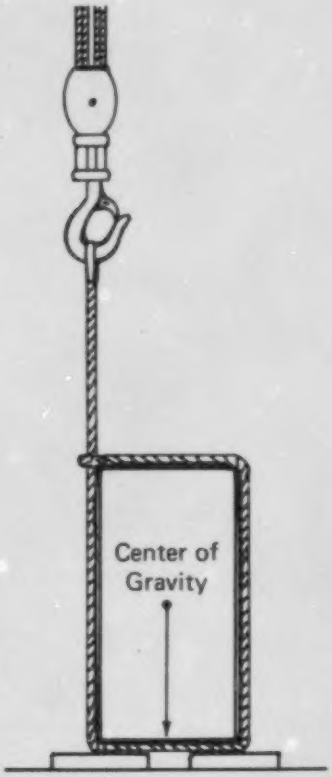
JOB SHEET #3

IV. Procedure for turning or rotating a load

A. Attach single sling so that the part of sling leading from hoist hook will go directly to bottom of load (Figure 6)

(NOTE: Be sure hook points away from hoist.)

FIGURE 6



B. Attach sling to hook

JOB SHEET #3

C. Take strain on sling and move hook forward; this will cause load to tilt (Figure 7)

FIGURE 7

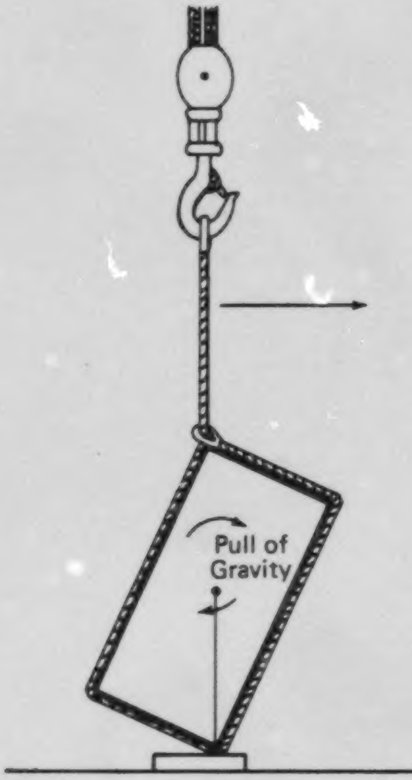
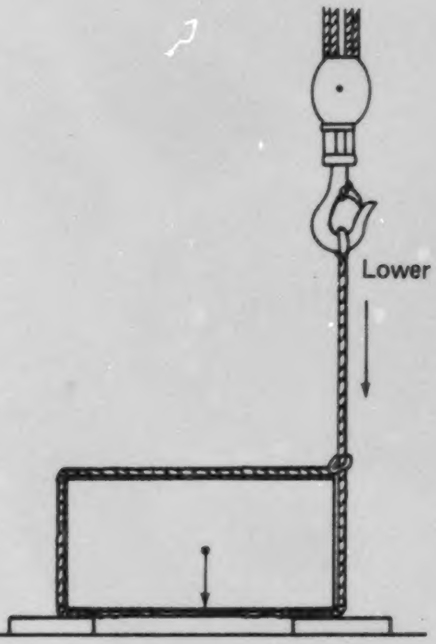


FIGURE 8



D. Continue to move forward, lowering the hook; this will let the load slowly rotate to a flat position (Figure 8)

RIGGING
UNIT III

TEST

NAME ______________________________ SCORE __________

1. Match terms associated with rigging to the correct definitions. Write the correct numbers in the blanks provided.

______a. Setting up block and tackle to a winch, stacking and hoisting material and equipment, and/or replacing cables on equipment

______b. To attach a rope to a post, pole, ring, hook, or other object

______c. Rope used to guide and/or steady load

______d. Pulled from underneath the load

______e. Pounds per square inch

______f. Assembly of blocks and lines used to aid in lifting or pulling

______g. Grooved wheel or pulley

______h. Preliminary shaping of wires so that they will lie in place

______i. Direction, length, or angle of twist of the strands in a rope or cable

______j. Pulley in a case which can be easily fastened to lines or objects by means of a hook, ring, or shackle

______k. Material used in the center of wire rope

______l. Devices used to prevent crushing of load and to lift extra long and heavy loads

______m. Point at which entire weight may be considered as concentrated

______n. Metal loop which engages a hook

______o. Grooved metal ring inserted in loop of rope to prevent wear

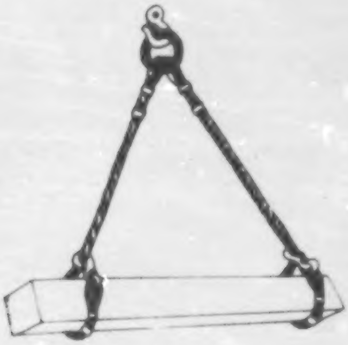
______p. Slang meaning to deliberately slow down the work pace

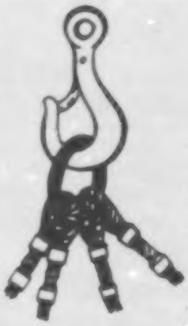
______q. To join two parts of a rope or wire to form a continuous length

1. Lay
2. Eye
3. Sheave
4. Rigging
5. Thimble
6. Snatch block
7. psi
8. Preforming
9. Tagline
10. Dog
11. Tackle
12. Heaved
13. Splice
14. Core
15. Hitch
16. Center of gravity
17. Spreaders

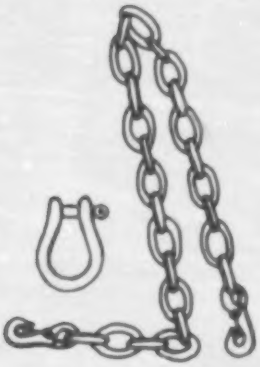
2. Identify the following accessories used for load lifting. Write the correct names in the blanks provided.

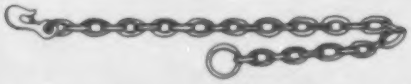
Bull chain
Bridles
Chokers (single slings)
Chain and shackle
Spreader bars
Grommet sling
Web sling



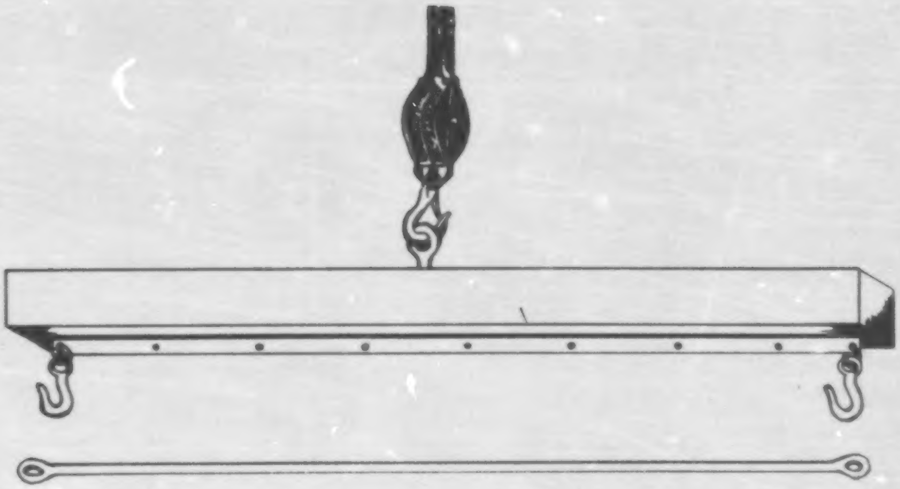


a. ______________________________

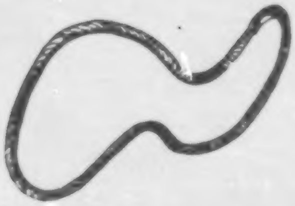


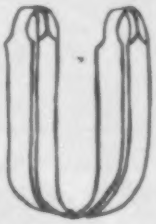


b. ____________________ c. ____________________

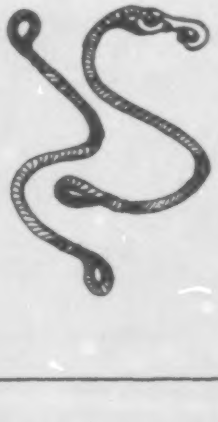


d. ____





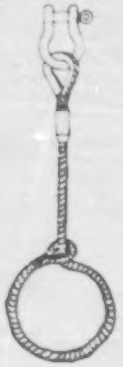
e. ______________________ f. ______________________



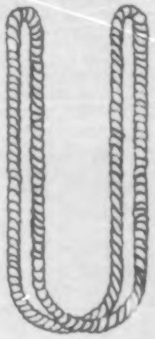
g. ________________________

3. Identify the following hitches used for attaching materials and equipment to the hoist. Write the correct names in the blanks provided.

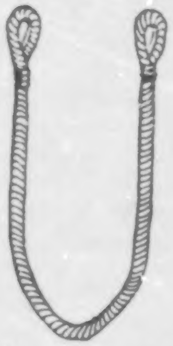
Choker hitch sling
Basket hitch sling
Choker hitch choker
Basket hitch choker
Inverted basket hitch sling



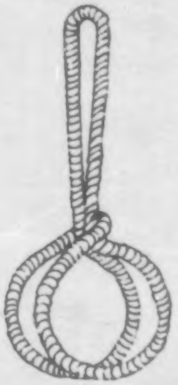
a. ______________________



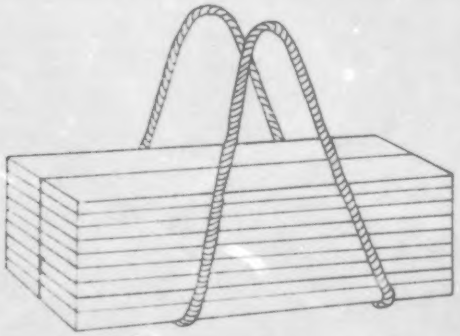
b. ______________________



c. ______________________

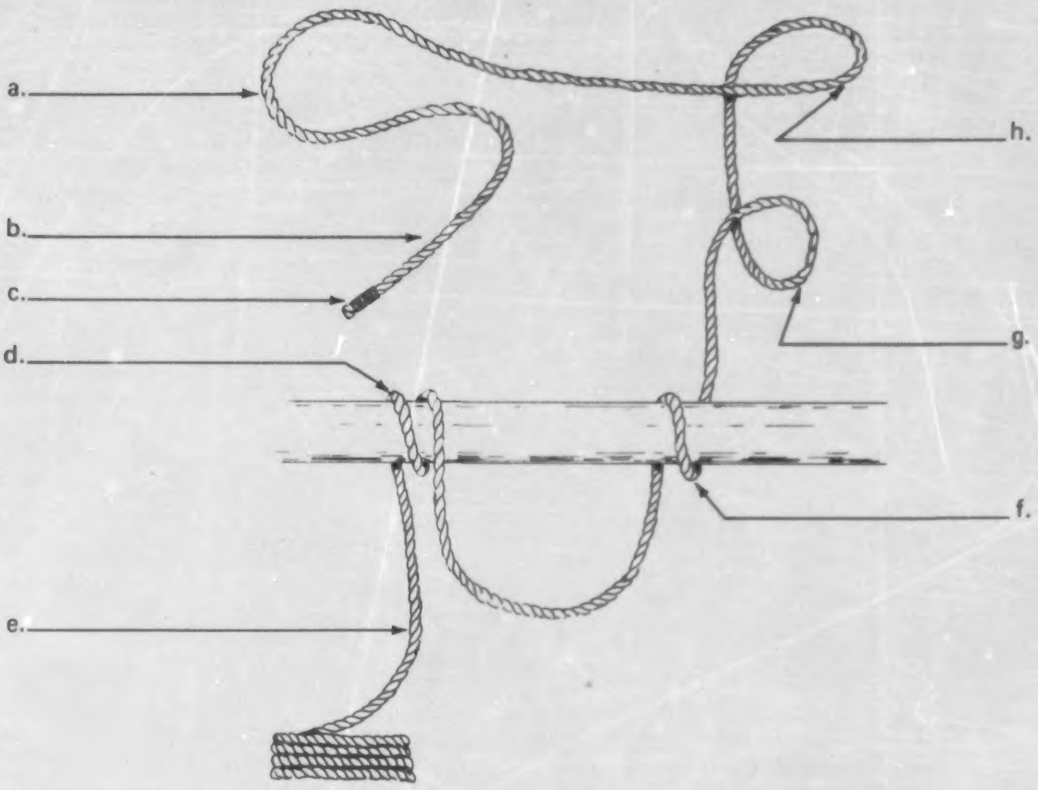


d. ______________________



e. ______________________

4. Label elements of knots, bends, and hitches. Write the correct names in the blanks provided.



5. Match types of knots to the correct uses. Write the correct numbers in the blanks provided.

_____a. Ties two lines of equal size together so that they will not slip

_____b. Forms a single loop that will not tighten or slip under strain

_____c. Fastens a line to timber or pipe

_____d. Ties line to timber or to a larger line

_____e. Holds timber securely when moving heavy timber or poles because of the pressure of one coil over other; the more tension applied, the tighter the hitch

_____f. Fastens a line to a hook; generally used temporarily

1. Half hitch
2. Bowline
3. Clove hitch
4. Square knot
5. Blackwall hitch
6. Timber hitch

______g. Forms a strong running loop which is convenient for running an eye; can also provide a choker-type sling at the end of a line

______h. Ties two lines of unequal size together; also used to tie a line to an eye

______i. Holds heavy timbers or poles for lifting or dragging

______j. Supports ends of scaffold plank and prevents it from tilting

______k. Secures the running end of a line to the standing part

7. Timber hitch with half hitch
8. Running bowline
9. Scaffold hitch
10. Two half hitches
11. Sheet bend

6. State five safety tips related to rigging.

a. ____

b. ____

c. ____

d. ____

e. ____

7. Match types of materials used in construction of ropes to their characteristics. Write the correct numbers in the blanks provided.

______a. Strong and durable; used where dependability, ability to stand up under severe use, and weathering are required

______b. Less durable, lower in strength; used where requirements are less demanding and low cost is a major factor

______c. Very strong, approximately twice the strength of manila; unusually high abrasion resistance, good resistance to weathering, and high degree of stretch

______d. Quite similar to nylon except somewhat lower in tensile strength and having much less stretch

______e. Slightly less strength than nylon, but a degree of stretch similar to terylene; very light, actually floats on water and is resistant to rot

______f. Has about same strength as polypropylene, but has a high stretch factor and excellent resistance to mildew, decay, acids, and alkalies

1. Polypropylene
2. Nylon
3. Manila
4. Terylene
5. Polyethylene
6. Sisal

8. Explain general construction of rope.

____

____

____

____

____

____

____

9. State six precautions to observe when caring for ropes.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

10. Calculate safe working load (SWL) of the following different types and sizes of ropes.

a. $\frac{3}{4}''$ manila rope

(Mathematical constant is 20.)

SWL = ______________

b. $\frac{3}{4}''$ nylon rope

(Mathematical constant is 60.)

SWL = ______________

c. $\frac{3}{8}''$ polyester rope

(Mathematical constant is 60.)

SWL = ______________

d. $\frac{3}{8}$" polyethylene rope

(Mathematical constant is 35.)

SWL = ____________

e. $1\frac{1}{8}$" polypropylene rope

(Mathematical constant is 40.)

SWL = ____________

11. State the importance of spreading angles.

a. ____

____

b. ____

____

c. ____

____

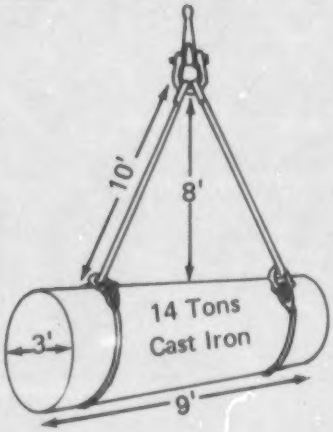
d. ____

____

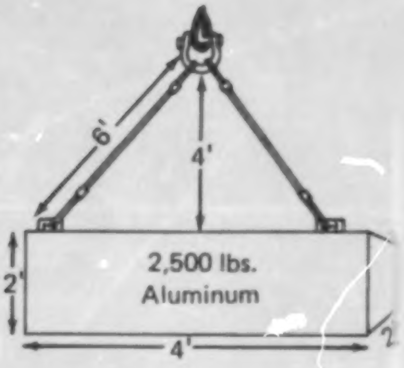
e. ____

12. Calculate sling stress using the following illustrations.

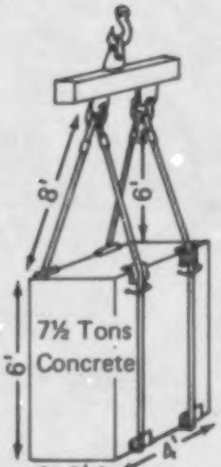
a. Stress = ____________



b. Stress = ______________

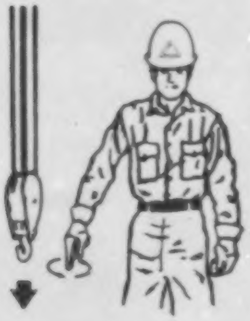

6'
4'
2'
2,500 lbs.
Aluminum
4'
2

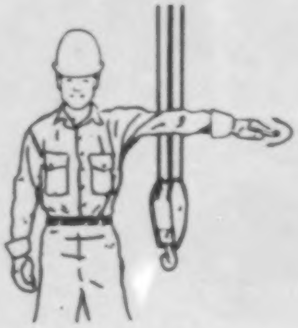
c. Stress = ______________

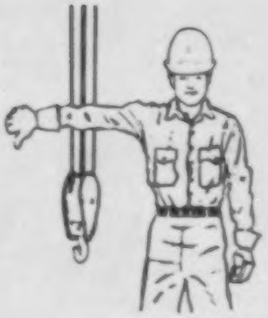

8'
6'
7½ Tons
Concrete
6'
3'
4'

13. Distinguish among hand signals used in rigging operations. Write an "X" in the blank under each correct illustration.

a. Lower the boom

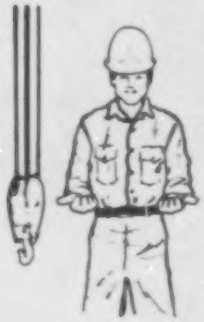


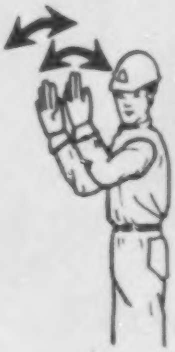


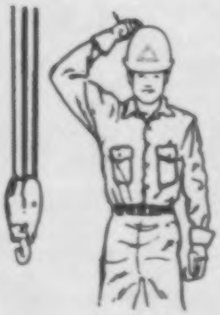


1) ________________ 2) ________________ 3) ________________

b. Straighten out

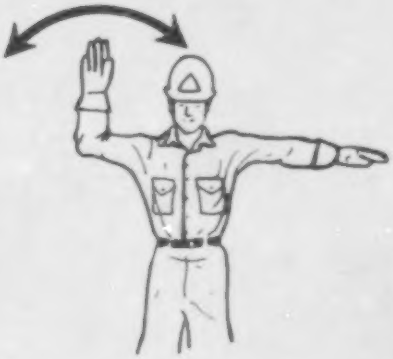


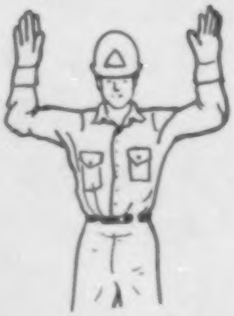


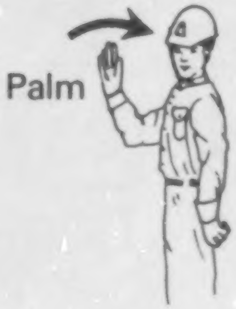


1) ________________ 2) ________________ 3) ________________

c. Move backwards

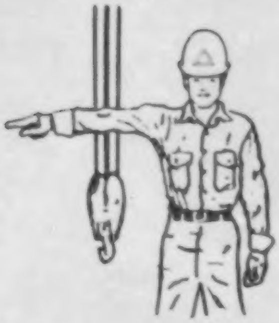
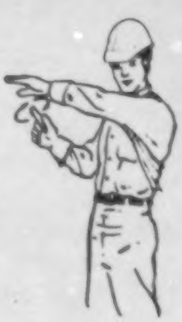
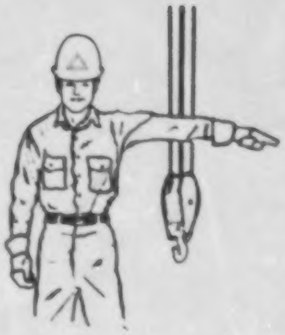






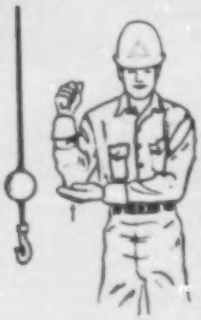
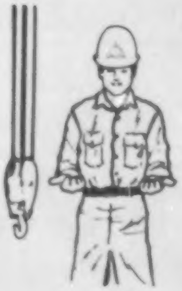
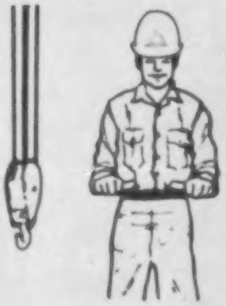
1) ________________ 2) ________________ 3) ________________

d. Swing

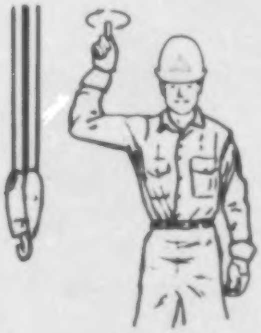
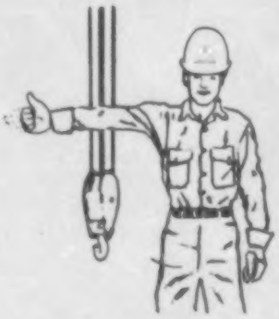
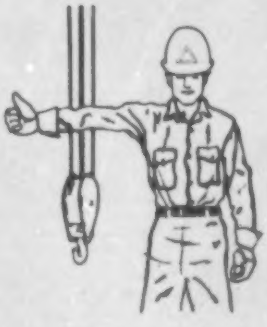
1) ______________ 2) ______________ 3) ______________

e. Retract boom

1) ______________ 2) ______________ 3) ______________

f. Raise the boom and lower the load

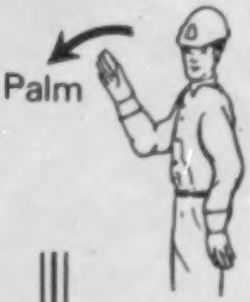
1) ______________ 2) ______________ 3) ______________

Write an "X" in the correct blanks.

g. ______1) Swing in direction finger points

______2) Move in this direction

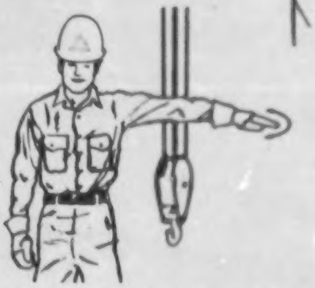
______3) Turn while moving



h. ______1) Stop

______2) Stop

______3) Emergency stop



14. Select from the following list construction characteristics of wire rope used with heavy equipment. Write an "X" in the correct blanks.

______a. Where rope lies

______b. Grade of steel wire used

______c. Number of turns around drum

______d. Preformed lay

______e. Size of wire in strand

______f. Number of wires in each strand

______g. Type of core

______h. Length of cable

______i. Name of cable

______j. Size of core

15. Match strengths of steel used in wire rope to their grades. Write the correct numbers in the blanks provided.

______a. Mild plow steel	1. 200,000 to 220,000 psi
______b. Improved plow steel	2. 240,000 to 260,000 psi
______c. Iron wire	3. 180,000 to 190,000 psi
______d. Traction steel	4. 100,000 psi
______e. Plow steel	5. 220,000 to 240,000 psi

16. Calculate safe working load (SWL) of the following different sizes of wire ropes.

    a. $\frac{3}{8}$" diameter rope

       SWL = ______________

    b. $\frac{3}{4}$" diameter rope

       SWL = ______________

    c. 1" diameter rope

       SWL = ______________

    d. $1\frac{1}{4}$" diameter rope

       SWL = ______________

    e. $1\frac{3}{8}$" diameter rope

       SWL = ______________

17. Arrange in order steps to take when performing maintenance on wire rope. Place in the blanks provided a "1" before the first step, a "2" before the second step, and so on.

    _____a. Apply oil by moving rope through a long pan

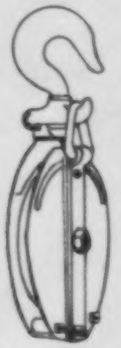
    _____b. Let cool and thicken

    _____c. Heat oil that is recommended by manufacturer

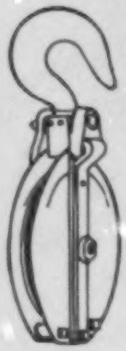
    _____d. Wipe off surplus oil as rope leaves the pan

    _____e. Check for frayed and/or worn parts

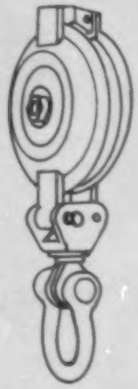
18. Label types of snatch blocks. Write the correct names in the blanks provided.



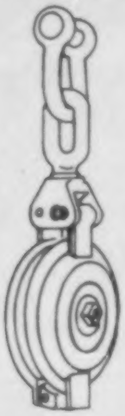
a. ____________________



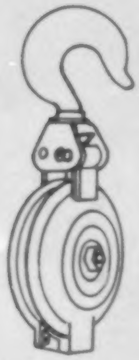
b. ____________________



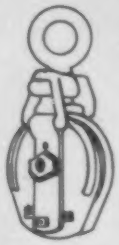
c. ____________________



d. ____________________



e. ____________________



f. ____________________

19. Select from the following list types of cable fittings. Write an "X" in the correct blanks.

_____a. Drop forged steel swivel hook and socket

_____b. Midget turn buckle

_____c. Closed socket with chain

_____d. Closed socket for flat rope

_____e. Jaw and eye turnbuckle

_____f. Eye bolt with nut

_____g. Swaged clevis fitting

______h. Rope binding hook

______i. Standard shackle

______j. S-hook

______k. Turnbuckle with spliced rope

______l. Tie-out chain

______m. Drop forged steel hook with eye

______n. Safety snap hook

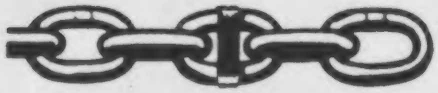
______o. Lock link wire chain

______p. Drop forged steel hook with shank

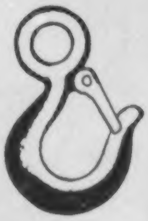
______q. Screw pin shackle

20. Identify the following types of towing chains and accessories. Write the correct names in the blanks provided.

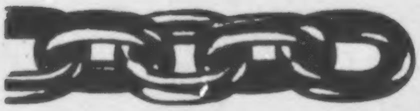
Shackles
Proof chain
Alloy chain
Swivels
Slip hook
BBB chain
Grab hook
Rings
High test chain
Safety hook



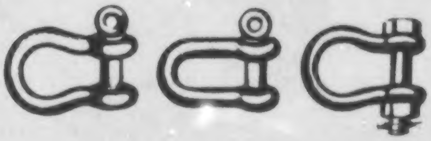
a. ______________________________



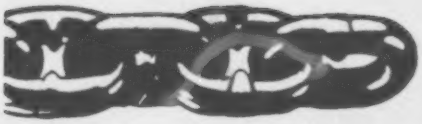
b. ______________________________



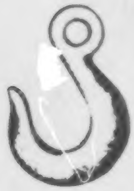
c. ______________________________



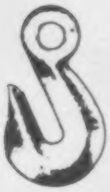
d. ______________________________



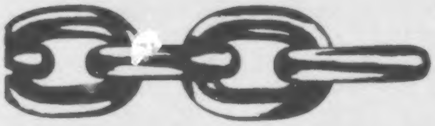
e. ______________________________



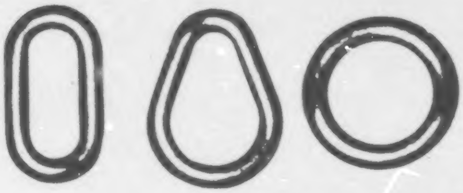
f. ______________________________



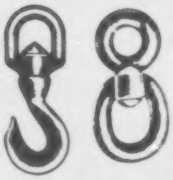
g. ______________________________



h. ______________________________



i. ______________________________



j. ______________________________

21. Select from the following list good rigging practices. Write an "X" in the correct blanks.

______a. Pad all sharp corners and edges

______b. Use tag line to pull loads

______c. Wrap rope around hook when not in use

______d. Center crane over load before lifting

______e. Give all hand signals clearly and correctly

______f. Secure all unused sling lines

______g. Turn hooks to face hoist

______ h. Never allow a shackle to be pulled at an angle

______ i. Unhook load as soon as it is low enough to reach

______ j. Use a shackle whenever two or more ropes are to be used over a hook

22. Distinguish among types of knots.

23. Demonstrate the ability to:

    a. Tie knots.

    b. Install wire rope clips.

    c. Rig and handle different types of loads.

    (NOTE: If activities 22 and 23 have not been finished before the test, ask your instructor when they should be completed.)

RIGGING
UNIT III

ANSWERS TO TEST

1. a. 4
   b. 15
   c. 9
   d. 12
   e. 7
   f. 11
   g. 3
   h. 8
   i. 1
   j. 6
   k. 14
   l. 17
   m. 16
   n. 2
   o. 5
   p. 10
   q. 13

2. a. Bridles
   b. Chain and shackle
   c. Bull chain
   d. Spreader bars
   e. Grommet sling
   f. Web sling
   g. Chokers (single slings)

3. a. Choker hitch choker
   b. Basket hitch sling
   c. Basket hitch choker
   d. Choker hitch sling
   e. Inverted basket hitch sling

4. a. Bight
   b. Running end
   c. Whipping
   d. Round turn
   e. Standing part
   f. Turn
   g. Underhand loop
   h. Overhand loop

5. a. 4
   b. 2
   c. 3
   d. 1
   e. 6
   f. 5
   g. 8
   h. 11
   i. 7
   j. 9
   k. 10

6. Any five of the following:

   a. Use personal protective devices such as goggles, gloves, safety shoes, and hard hats
   b. Use tag line to guide and/or steady load
   c. Do not walk under load
   d. Be sure load is balanced properly
   e. Do not overload equipment
   f. Stand clear when slings are heaved from under loads
   g. Be sure outriggers and/or stabilizers are in use and are on solid footing
   h. Be extra cautious around power lines
   i. Use corner saddles, padding, or wood blocking to protect slings from sharp bends and sharp edges
   j. Avoid heavy or continuous overloading
   k. Lubricate slings to prevent rust
   l. Be sure all hooks have safety snaps

7. a. 3
   b. 6
   c. 2
   d. 4
   e. 1
   f. 5

8. Answer should include:

   a. Rope is normally made of three strands, each of which is made of several threads
   b. The rope itself is twisted in a right-hand direction while each strand is twisted in a left-hand direction and the individual threads are twisted in a right-hand direction
   c. Reversal of twist in strands gives the rope a balance or set which eliminates the tendency to unwind

9. Any six of the following:

   a. When taking rope from a coil, always remove it from the center in a counter-clockwise direction

   b. When rope is not in use, it should be re-coiled in a clockwise direction

   c. When rope is attached to a hook, ring, or pulley block, a thimble should be placed in the loop or eye to reduce wear and to decrease stress

   d. Protect rope from moisture and weather as much as possible

   e. Do not disturb a frozen rope until completely thawed

   f. Keep rope away from acids, other chemicals, and heat

   g. Do not drag rope over ground or sharp edges

   h. If possible, do not make abrupt bends in rope

   i. Dirty rope should be washed and dried before being stored

   j. Store rope so that air may circulate around it

   k. If manila rope becomes stiff and hard because of being wet, treat with a thin lubricating oil or warm petrolatum (a jelly-like petroleum based dressing)

10. a. 720 lbs

   b. 2160 lbs

   c. 540 lbs

   d. 315 lbs

   e. 3240 lbs

11. a. Changing angle of sling leg may increase stress on the sling

   b. As the angle is reduced, lifting capacity is reduced very rapidly

   c. When single leg of sling is at 60° angle, lifting capacity is only 87 percent of that of a vertical leg

   d. When single leg of sling is at 45° angle, lifting capacity is 71 percent of that of a vertical leg

   e. When single leg of sling is at 30° angle, lifting capacity is 50 percent of that of a vertical leg

12. a. $8\frac{3}{4}$ tons

   b. 1875 lbs

   c. $2\frac{1}{2}$ tons

13. a. 3
    b. 2
    c. 3
    d. 1
    e. 3
    f. 2
    g. 2
    h. 3

14. b, d, e, f, g

15. a. 1
    b. 2
    c. 4
    d. 3
    e. 5

16. a. $1\frac{1}{8}$ tons
    b. $4\frac{1}{2}$ tons
    c. 8 tons
    d. $12\frac{1}{2}$ tons
    e. $15\frac{1}{8}$ tons

17. a. 3
    b. 5
    c. 2
    d. 4
    e. 1

18. a. Drop link
    b. Self locking
    c. Swivel shackle
    d. Upset swivel shackle
    e. Swivel hook
    f. Swivel eye

19. a, c, d, g, i, k, m, n, p, q

20. a. High test chain
    b. Safety hook
    c. BBB chain
    d. Shackles
    e. Alloy chain
    f. Slip hook
    g. Grab hook
    h. Proof chain
    i. Rings
    j. Swivels

21. a, d, e, f, h, j

22. Evaluated to the satisfaction of the instructor

23. Performance skills evaluated to the satisfaction of the instructor

OXYACETYLENE CUTTING
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to set up, light, adjust, and use an oxyacetylene cutting outfit. This knowledge will be shown by completion of job sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with oxyacetylene cutting to the correct definitions.
2. State rules for safe handling of oxygen and acetylene equipment.
3. Select from a list color codes for oxygen and acetylene.
4. Label parts of an oxyacetylene cutting outfit.
5. Label parts of a torch body and cutting attachment.
6. Identify types of oxyacetylene cutting flames.
7. Arrange in order steps to follow in case of a flashback.
8. Select from a list causes of a backfire.
9. Distinguish between flashback and backfire.
10. Identify a multi-flame heating nozzle (rosebud) and tip.
11. Describe uses of a multi-flame heating nozzle (rosebud).
12. Demonstrate the ability to:
    a. Set up equipment for oxyacetylene cutting.
    b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.
    c. Cut mild steel at a ninety-degree angle, stop, and restart the cut.
    d. Cut round stock.
    e. Cut cable.

OXYACETYLENE CUTTING
UNIT IV

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Make transparencies.

  D. Discuss unit and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Have students demonstrate the ability to use equipment safely and according to the recommended uses.

  H. Secure color flame charts from welding supplier to show types of flames.

  I. Obtain film from local welding supplier to show various techniques in cutting.

  J. Give test.

II. Instructional materials:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1–Oxyacetylene Cutting Outfit

    2. TM 2–Parts of a Torch Body and Cutting Attachment

  D. Job sheets

    1. Job Sheet #1--Set Up Equipment for Oxyacetylene Cutting

    2. Job Sheet #2--Turn On, Light, Adjust to a Neutral Flame, and Turn Off Oxyacetylene Cutting Equipment

    3. Job Sheet #3--Cut Mild Steel at a Ninety-Degree Angle, Stop, and Restart the Cut

    4. Job Sheet #4--Cut Round Stock

    5. Job Sheet #5–Cut Cable

E. Test

F. Answers to test

III. Unit reference--Hendrix, Laborn J. "Bud." *Millwright Instructional Materials*. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Associated General Contractors of America, 1980.

OXYACETYLENE CUTTING
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Acetylene--Colorless, gaseous hydrocarbon used chiefly in welding

(NOTE: There are other gases that will do the same job.)

B. Oxygen--Element that is normally a colorless, odorless, and tasteless gas; used in combination with other substances in welding

C. Oxyacetylene cutting--Cutting of metal using the oxygen jet which is used with an oxygen-acetylene preheating flame

D. Purge--To remove any foreign material from a system or component by flushing with the gas used in that system

E. psi--Pounds per square inch

F. Combustible--Capable of burning

G. Toxic--Poisonous

H. Journal--That part of a shaft, axle, or spindle which turns in a bearing

I. Flint lighter--Striker used to ignite torch

J. Slag box--Metal container with a layer of water or sand to catch hot material

K. Slag--Metal that melts away during the oxyacetylene cutting process

L. Seizing--Firmly binding cable with soft iron wire

II. Rules for safe handling of oxygen and acetylene equipment

A. **Do not** use oil on regulators, torches, fittings, or on any place which it may come in contact with oxygen

(CAUTION: **Never** oil or grease oxygen fittings because substances will unite with explosive violence.)

B. **Do not confuse oxygen with compressed air**

C. **Do not** use acetylene at pressures higher than 15 psi

(NOTE: Acetylene becomes unstable at pressures higher than 15 psi and becomes highly explosive.)

INFORMATION SHEET

D. **Do not** leave a burning torch unattended

E. **Do not** cut or weld directly on gravel or concrete

F. **Do not** weld on containers that have been used for combustible materials unless they have been cleaned and purged

G. Secure cylinders to prevent damage to valves and regulators and to prevent injuries

H. Purge cylinder valve before attaching regulators

I. Release adjusting screws on regulator before opening cylinder valve

J. Stand to one side of regulator while slowly opening cylinder valve

K. Purge oxygen and acetylene passages before lighting torch

L. Light acetylene gas before opening oxygen valve on torch

M. Keep heat, flames, and sparks away from combustibles

N. Use safety goggles, gloves, and protective clothing

(CAUTION: Keep gloves, hands, and clothing free from oil and grease.)

O. Test connections for leaks with Ivory soap and paint brush.

P. Avoid breathing toxic fumes when welding

Example: Galvanized metal

Q. Open torch in a well-ventilated place

R. Weld or cut at least five feet from cylinders

S. Protect hoses from hot metal, rupture, or mechanical damage

(NOTE: Instructor may add other safety rules.)

III. Color codes for oxygen and acetylene

A. Oxygen--Green

B. Acetylene--Red

IV. Parts of an oxyacetylene cutting outfit (Transparency 1)

A. Oxygen cylinder

B. Oxygen regulator

C. Oxygen pressure regulating screw

INFORMATION SHEET

D. Oxygen cylinder valve

E. Acetylene cylinder

F. Acetylene regulator

G. Acetylene pressure regulating screw

H. Acetylene cylinder valve

I. Safety chain

J. Cylinder truck

K. Oxygen hose

L. Acetylene hose

M. Oxygen fitting

(NOTE: The oxygen fitting has right-hand threads.)

N. Acetylene fitting

(NOTE: The acetylene fitting has left-hand threads with grooved nuts.)

O. Oxygen torch valve

P. Torch body

Q. Acetylene torch valve

R. Cutting attachment

S. Oxygen preheat valve

T. Oxygen cutting lever

U. Tip

V. Tip nut

W. Flint lighters

X. Welding goggles

Y. Welding gloves

Z. Tip cleaners

INFORMATION SHEET

V. Parts of a torch body and cutting attachment (Transparency 2)

A. Cutting torch

1. Oxygen fitting
2. Acetylene fitting
3. Oxygen torch valve
4. Acetylene torch valve
5. Torch body
6. Oxygen cutting lever
7. Oxygen preheat valve
8. Tip nut
9. Tip

B. Cutting tip

(NOTE: The selection of the correct tip for the job is determined by the thickness of metal, the size of tip orifice, and the oxygen cutting pressure. See manufacturer's recommendations.)

1. Preheat orifice

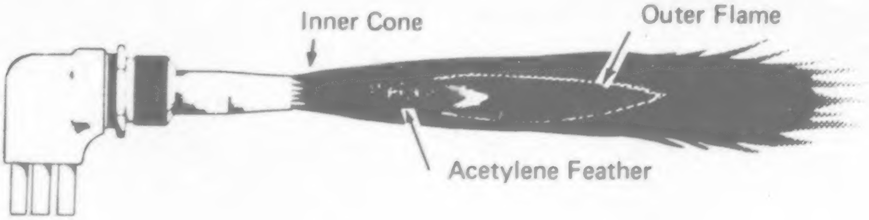
   (NOTE: The preheat orifice heats metal to kindling point of approximately 1600°F [755°C].)

2. Cutting orifice

   (NOTE: The cutting orifice removes oxidized metal.)

VI. Types of oxyacetylene cutting flames

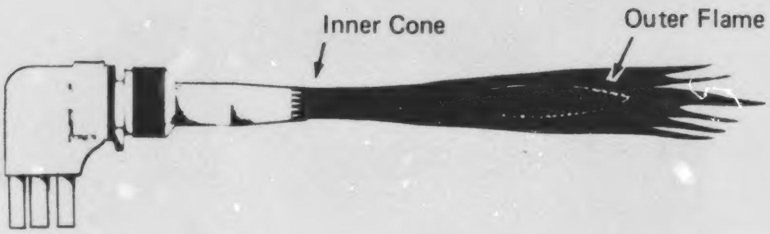
A. Carburizing flame



(NOTE: The flame has an excess of acetylene gas.)

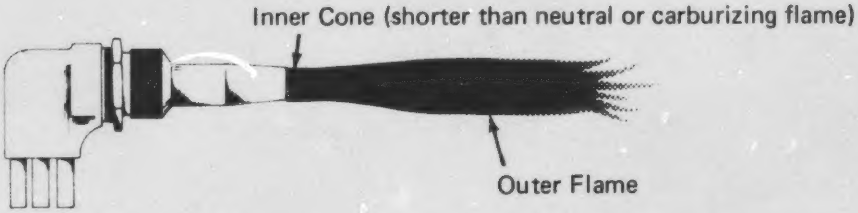
INFORMATION SHEET

B. Neutral flame


Inner Cone
Outer Flame

(NOTE: The flame has the proper ratio of oxygen to acetylene.)

C. Oxidizing flame


Inner Cone (shorter than neutral or carburizing flame)
Outer Flame

(NOTE: The flame has an excess of oxygen.)

VII. Steps to follow in case of a flashback

A. Close oxygen preheat valve

B. Close oxygen torch valve

C. Close acetylene torch valve

INFORMATION SHEET

D. Release oxygen regulator screw

E. Release acetylene regulator screw

F. Examine acetylene unit

G. Reset regulator pressures

H. Light torch

(NOTE: If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, shut off the oxygen and acetylene cylinder and then notify the supervisor.)

VIII. Causes of a backfire

A. Not enough acetylene or oxygen pressure

B. Loose cutting tip

C. Dirty tip

D. Overheating of cutting tip

E. Bad "O" ring in torch body

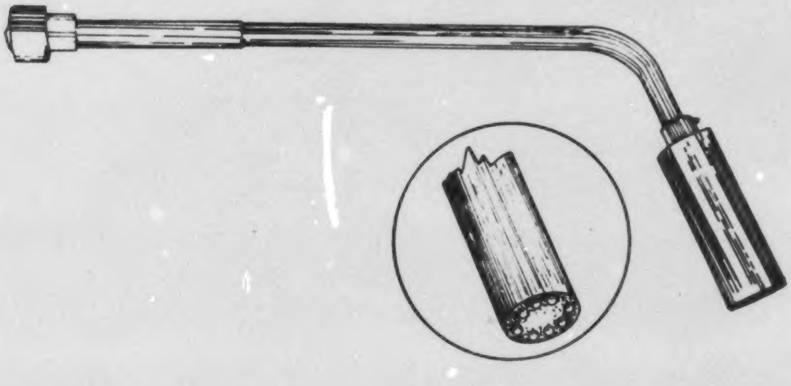
(NOTE: The above causes should be carefully checked to control backfire

IX. Differences between flashback and backfire

A. Flashback--Flame disappears inside torch body; at the same time, a squealing noise occurs and smoke and/or sparks are emitted from the torch tip

B. Backfire--Flame burns momentarily back into tip; then a loud snap or pop is emitted from the torch and the flame either goes out or continues to burn in a normal manner

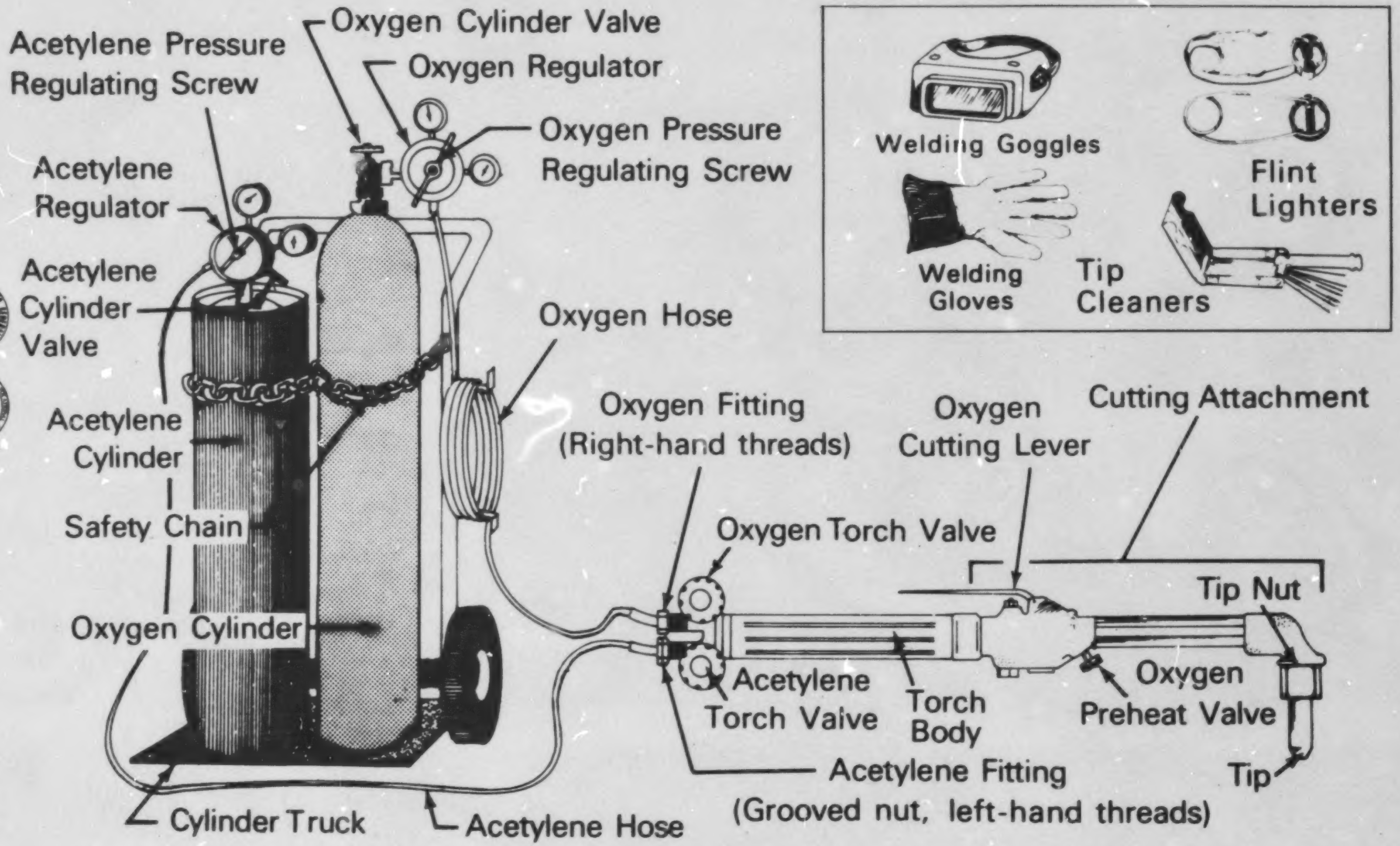
X. Multi-flame heating nozzle (rosebud) and tip



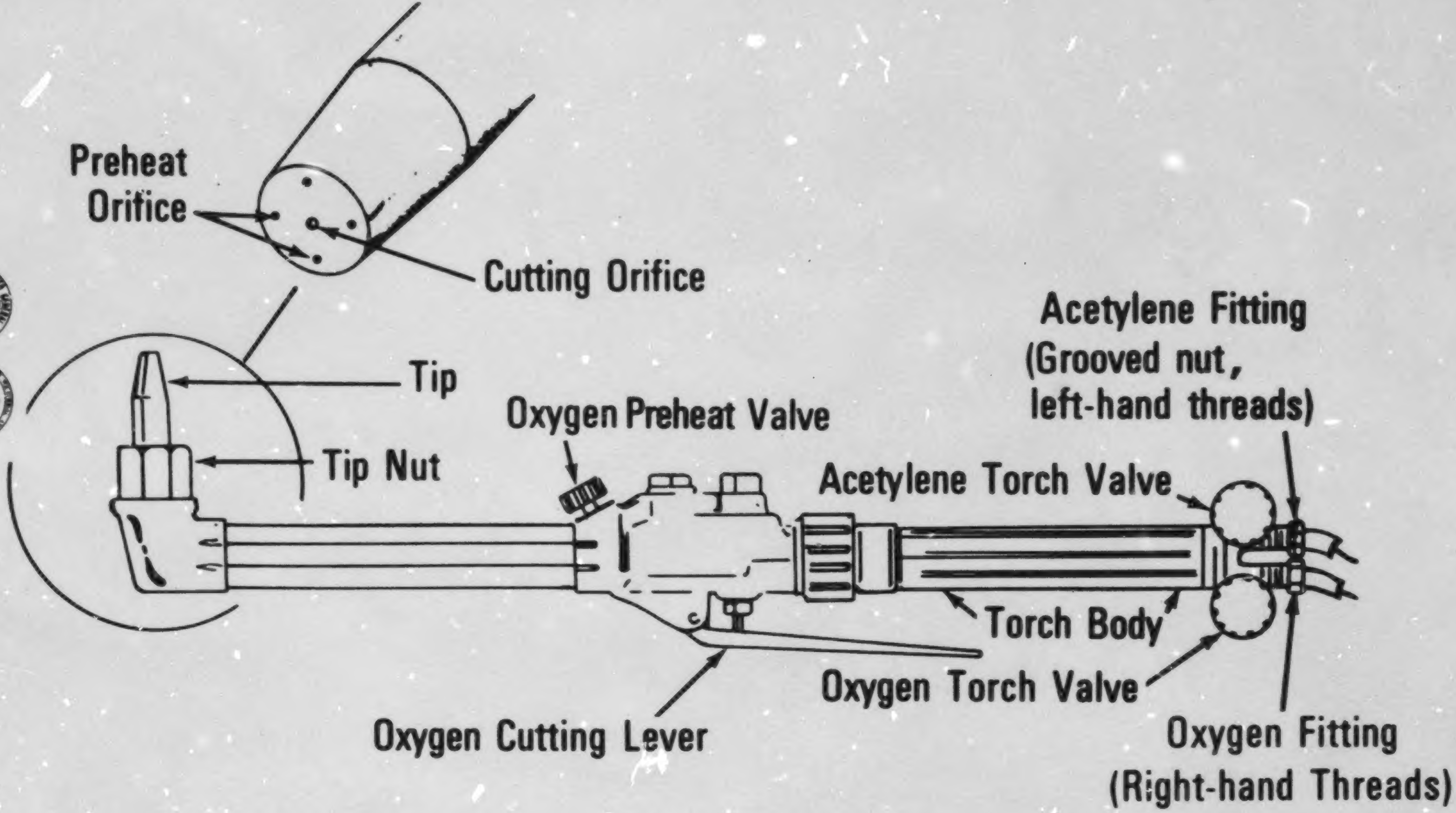
INFORMATION SHEET

XI. Uses of a multi-flame heating nozzle (rosebud)--Used to heat parts and/or metals, such as bearings, before fitting them to the journal; also used to preheat metal before welding

Oxyacetylene Cutting Outfit


Oxygen Cylinder Valve
Acetylene Pressure Regulating Screw
Oxygen Regulator
Oxygen Pressure Regulating Screw
Acetylene Regulator
Acetylene Cylinder Valve
Oxygen Hose
Acetylene Cylinder
Safety Chain
Oxygen Cylinder
Cylinder Truck
Acetylene Hose
Oxygen Fitting (Right-hand threads)
Oxygen Cutting Lever
Cutting Attachment
Oxygen Torch Valve
Tip Nut
Acetylene Torch Valve
Torch Body
Oxygen Preheat Valve
Acetylene Fitting (Grooved nut, left-hand threads)
Tip
Welding Goggles
Flint Lighters
Welding Gloves
Tip Cleaners

Parts of a Torch Body and Cutting Attachment


Preheat Orifice
Cutting Orifice
Tip
Tip Nut
Oxygen Preheat Valve
Acetylene Fitting (Grooved nut, left-hand threads)
Acetylene Torch Valve
Torch Body
Oxygen Torch Valve
Oxygen Cutting Lever
Oxygen Fitting (Right-hand Threads)

OXYACETYLENE CUTTING
UNIT IV

JOB SHEET #1--SET UP EQUIPMENT FOR OXYACETYLENE CUTTING

I. Tools and materials

- A. Oxygen cylinder
- B. Acetylene cylinder
- C. Oxygen regulator
- D. Acetylene regulator
- E. Hoses
- F. Wrench
- G. Cylinder holder
- H. Fire extinguisher
- I. Ivory soap
- J. Clean paintbrush
- K. Torch body with tips

II. Procedure

- A. Fasten cylinders in a vertical position
- B. Remove caps from cylinders
- C. Crack valves of each cylinder to remove foreign material; close valves
- D. Connect oxygen regulator to oxygen cylinder

  (CAUTION: Do not use oil on any connections in the oxyacetylene system.)

  1. Turn adjusting screw on regulator counterclockwise until tension on spring is released
  2. Turn cylinder valve wide open slowly
- E. Connect acetylene regulator to acetylene cylinder
  1. Turn adjusting screw on regulator counterclockwise until tension on spring is released
  2. Open cylinder valve 1/3 to 3/4 of a turn

     (NOTE: Never open cylinder valve more than 1 1/2 turns.)

JOB SHEET #1

F. Connect acetylene hose to acetylene regulator; purge hose

G. Connect oxygen hose to oxygen regulator; purge hose

H. Connect torch body to oxygen and acetylene hoses

I. Close both valves on torch body

J. Attach cutting attachment to torch body

(NOTE: The tip size is determined by the thickness of metal to be cut and the manufacturer's recommendations.)

K. Close oxygen preheat valve on cutting attachment

L. Turn adjusting screw on oxygen regulator clockwise until working pressure is reached

M. Turn adjusting screw on acetylene regulator clockwise until correct working pressure is reached

N. Use Ivory soap to test all connections for leaks

(NOTE: Apply soapsuds with a clean paintbrush.)

OXYACETYLENE CUTTING
UNIT IV

JOB SHEET #2--TURN ON, LIGHT, ADJUST TO A NEUTRAL FLAME, AND TURN OFF OXYACETYLENE CUTTING EQUIPMENT

I. Tools and materials

A. Oxyacetylene cutting outfit

B. Wrench

C. Gloves

D. Safety goggles

E. Coveralls or protective clothing

F. Flint lighter

G. Fire extinguisher

II. Procedure

A. Check all cylinder, regulator, and torch valves to make sure they are closed

B. Open acetylene cylinder valve 1/2 to 3/4 of a turn

(CAUTION: Never open cylinder valve more than 1 1/2 turns.)

C. Open acetylene valve on torch one turn

D. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached

(NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

(CAUTION: Acetylene becomes unstable at pressures higher than 15 psi and becomes highly explosive.)

E. Close acetylene valve on torch

F. Open oxygen cylinder valve all the way

G. Open oxygen torch valve all the way

H. Open oxygen preheat valve on cutting attachment one turn

I. Turn adjusting screw on oxygen regulator clockwise until desired pressure is reached

J. Close oxygen preheat valve on cutting attachment

JOB SHEET #2

K. Open acetylene valve on torch 1/4 turn

L. Light the torch with flint lighter and adjust until smoke on flame clears

M. Open oxygen preheat valve slowly and adjust to a neutral flame

N. Depress the oxygen cutting lever and check to see that a neutral flame is present

(NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured.)

O. Close acetylene valve on torch

P. Close oxygen preheat valve

Q. Close acetylene cylinder valve

R. Close oxygen cylinder valve

S. Open acetylene valve on torch

(NOTE: When gages reach "O," close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.)

T. Open oxygen preheat valve on torch

(NOTE: When gages reach "O," close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.)

U. Close oxygen valve on torch

V. Place torch and hose on hanger or brackets provided

OXYACETYLENE CUTTING
UNIT IV

JOB SHEET #3--CUT MILD STEEL AT A NINETY-DEGREE ANGLE, STOP, AND RESTART THE CUT

I. Tools and materials

- A. Cutting outfit with tip assembly
- B. Mild steel plate, 1/4" to 1/2" thick x 4" wide, or wider, x 8" long, or longer
- C. Soapstone with a sharp point or edge
- D. Straightedge
- E. Gloves
- F. Safety goggles
- G. Pliers
- H. Coveralls
- I. Flint lighter
- J. Welding or cutting table
- K. Slag box
- L. Can of water
- M. Cutting tip
- N. Fire extinguisher

II. Procedure

- A. Make a ninety-degree cut
    1. Mark four parallel lines 2" apart on plate to be cut
    2. Adjust oxygen regulator
    3. Adjust acetylene regulator
    4. Place plate to be cut over slag box
    5. Light torch
    6. Adjust to neutral flame
    7. Assume comfortable position

JOB SHEET #3

8. Place hoses behind you

9. Maneuver torch as required

   (NOTE: Sometimes it is necessary to use both hands to hold torch steady for a straight cut.)

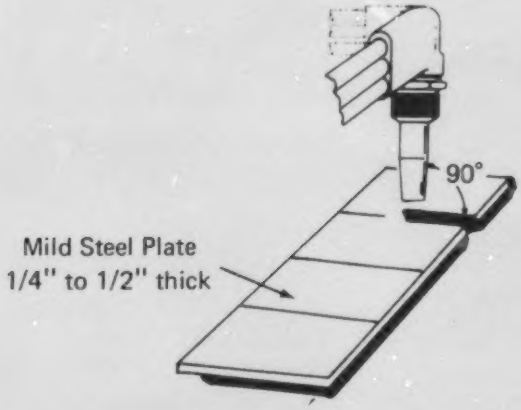
10. Hold preheat flame with tip of inner cone 1/16"-1/8" above top of plate at right edge until red spot appears

    (CAUTION: Metal burns; it does not melt.)

11. Depress the oxygen cutting lever and move from right to left across the plate (Figure 1)

    (NOTE: For left-handed operators, move from left to right.)

    FIGURE 1



12. Hold the tip at right angle to work while cutting with inner cone being approximately 1/16" above work

13. Make 90° cuts until you have developed the proper procedure

14. Cool metal by placing in can of water with the aid of pliers

B. Restart a cut

   1. Release the oxygen cutting lever

   2. Preheat only the edge where cutting action was stopped

   3. Depress oxygen cutting lever slowly and continue cut

OXYACETYLENE CUTTING
UNIT IV

JOB SHEET #4--CUT ROUND STOCK

I. Tools and materials

- A. Cutting outfit
- B. Pieces of reinforcing bar, 1/2", 5/8", 3/4", or 1"
- C. Soapstone with sharp point or edge
- D. Tape
- E. Gloves
- F. Safety goggles
- G. Pliers
- H. Coveralls
- I. Flint lighter
- J. Welding or cutting table
- K. Slag box
- L. Can of water
- M. Cutting tip
- N. Fire extinguisher

II. Procedure

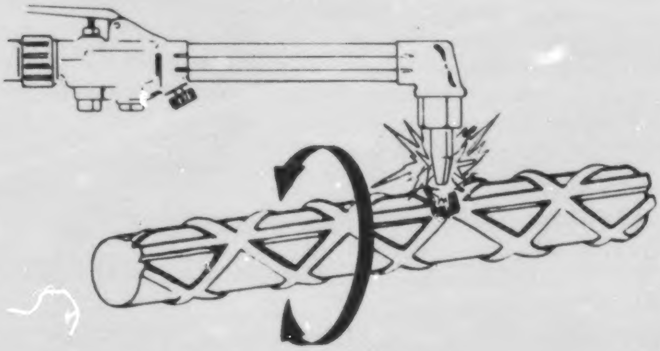
- A. Mark reinforcing bar at desired length
- B. Adjust oxygen and acetylene regulators
- C. Place area to be cut over slag box
- D. Light torch
- E. Adjust to neutral flame
- F. Assume comfortable position
- G. Place hoses behind you
- H. Maneuver torch as required

JOB SHEET #4

I. Hold preheat flame with tip of inner cone 1/16" to 1/8" above edge of reinforcing bar until it becomes red

J. Depress the cutting lever and rotate torch tip in the direction of travel until rod is cut (Figure 1)

FIGURE 1



K. Hold the tip at right angle to work while cutting with inner cone approximately 1/16" above work

L. Cool metal by placing in can of water with the aid of pliers

M. Repeat procedure for each bar or rod

OXYACETYLENE CUTTING
UNIT IV

JOB SHEET #5--CUT CABLE

I. Tools and materials

  A. Cutting outfit

  B. Cutting tip

  C. Flint lighter

  D. Piece of cable

  E. Soapstone

  F. Safety goggles

  G. Gloves

  H. Can of water

  I. Fire extinguisher

II. Procedure

  A. Determine where cable is to be cut

  B. Adjust oxygen and acetylene regulators

  C. Place fire extinguisher near work area

  D. Light torch

  E. Adjust to neutral flame

  F. Assume comfortable position

  G. Place hoses behind you

  H. Maneuver torch as required

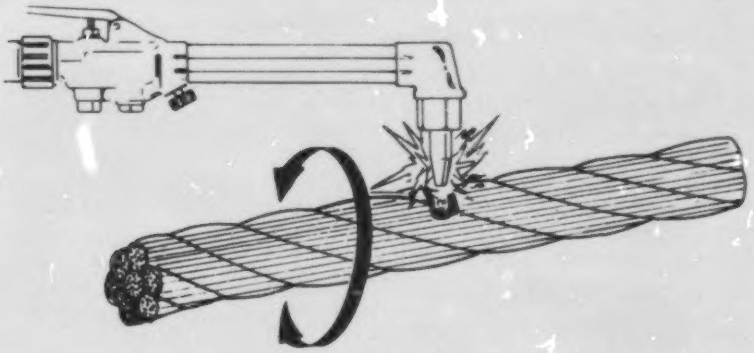
  (CAUTION: If there is tension on the cable, care must be taken to avoid ends flying loose when the cable is cut. This can be very dangerous.)

  I. Hold preheat flame with tip of inner cone 1/16" to 1/8" above edge of cable until it becomes red

JOB SHEET #5

J. Depress the cutting lever and rotate torch tip in the direction of travel until cable is cut (Figure 1)

FIGURE 1



K. Hold tip at right angle to work while cutting with inner cone approximately 1/16" above work

L. Cool metal by pouring water over hot ends

M. Repeat procedure for each cut

(NOTE: This is a very good method to use on all types of cables as it is quick, easy, and will weld the ends, which prevents raveling and reduces strain on the seizing.)

OXYACETYLENE CUTTING
UNIT IV

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with oxyacetylene cutting to the correct definitions. Write the correct numbers in the blanks provided.

______a. Colorless, gaseous hydrocarbon used chiefly in welding

______b. Element that is normally a colorless, odorless, and tasteless gas; used in combination with other substances in welding

______c. Cutting of metal using the oxygen jet which is used with an oxygen-acetylene preheating flame

______d. To remove any foreign material from a system or component by flushing with the gas used in that system

______e. Pounds per square inch

______f. Capable of burning

______g. Poisonous

______h. That part of a shaft, axle, or spindle which turns in a bearing

______i. Striker used to ignite torch

______j. Metal container with a layer of water or sand to catch hot material

______k. Metal that melts away during the oxyacetylene cutting process

______l. Firmly binding cable with soft iron wire

1. Toxic
2. Purge
3. Oxygen
4. Combustible
5. Oxyacetylene cutting
6. psi
7. Acetylene
8. Seizing
9. Flint lighter
10. Journal
11. Slag box
12. Slag

2. State ten rules for safe handling of oxygen and acetylene equipment.

a. ____

____

b. ____

____

c. ____

____

d. ____

____

e. ____

____

f. ____

____

g. ____

____

h. ____

____

i. ____

____

j. ____

____

3. Select from the following list color codes for oxygen and acetylene. Write an "O" for oxygen and an "A" for acetylene in the blanks provided.

_____a. Purple

_____b. Yellow

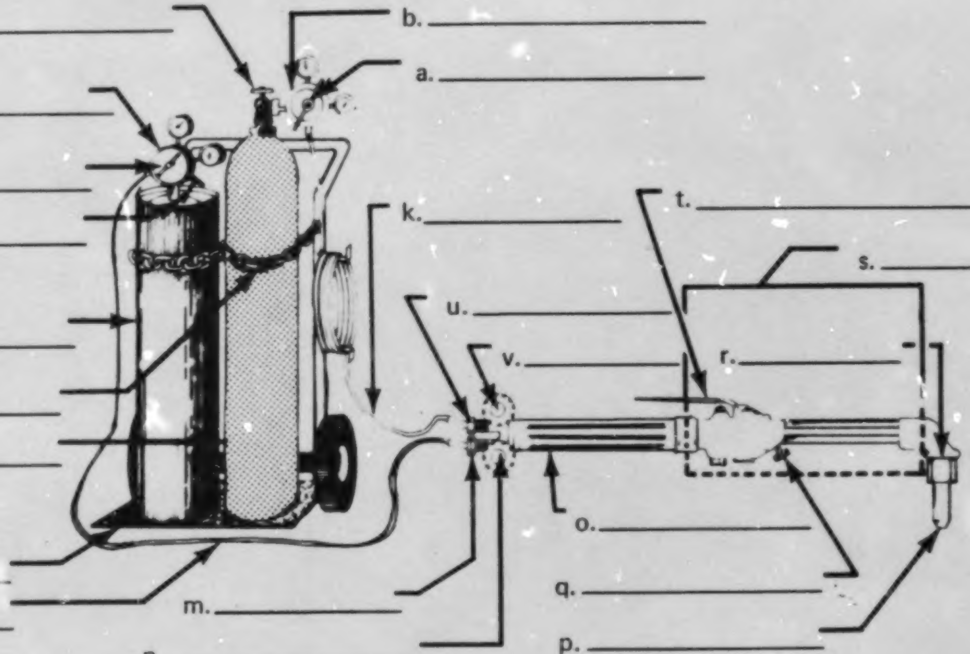
_____c. Green

_____d. Black

_____e. Red

_____f. Blue

4. Label parts of an oxyacetylene cutting outfit in the illustration below. Write the correct names in the blanks provided.



c. ______________________

b. ______________________

a. ______________________

d. ______________________

e. ______________________

f. ______________________

k. ______________________

t. ______________________

s. ______________________

u. ______________________

v. ______________________

r. ______________________

g. ______________________

h. ______________________

i. ______________________

o. ______________________

j. ______________________

q. ______________________

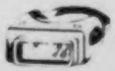
l. ______________________

m. ______________________

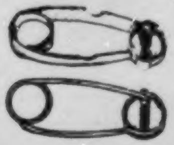
p. ______________________

n. ______________________

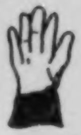
w. ______________________



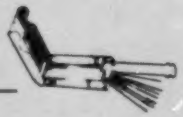
x. ______________________



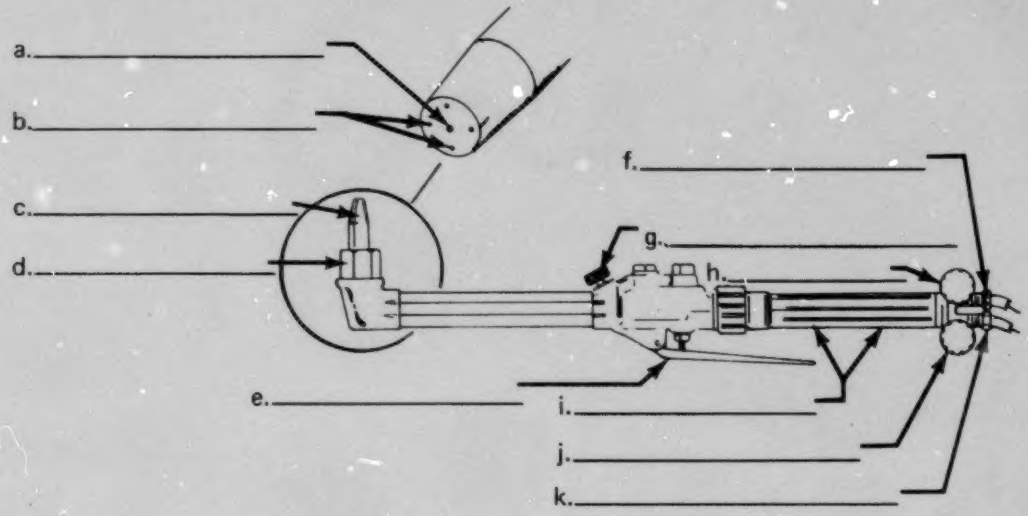
y. ______________________



z. ______________________

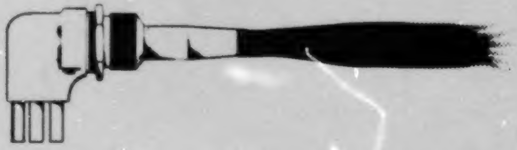


5. Label parts of a torch body and cutting attachment in the illustration below. Write the correct names in the blanks provided.

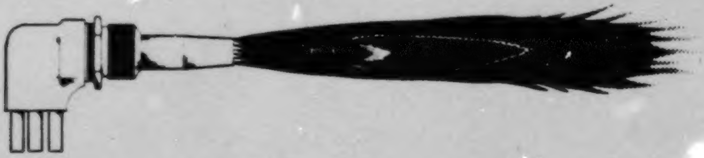


6. Identify the following types of oxyacetylene cutting flames. Write the correct terms in the blanks provided.

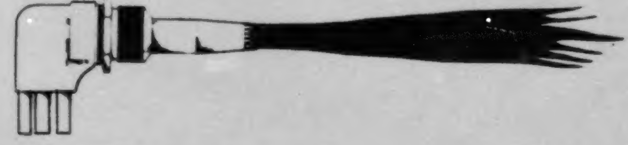
Carburizing flame   Oxidizing flame   Neutral flame



a. ______________________________



b. ______________________________



c. ______________________________

7. Arrange in order steps to follow in case of a flashback. Write a "1" before the first step, a "2" before the second step, and so on in the blanks provided.

   ______a. Light torch

   ______b. Release oxygen regulator screw

   ______c. Reset regulator pressures

   ______d. Close oxygen torch valve

   ______e. Close oxygen preheat valve

   ______f. Release acetylene regulator screw

   ______g. Close acetylene torch valve

   ______h. Examine acetylene unit

8. Select from the following list causes of a backfire. Mark each correct answer with an "X."

   ______a. Too much oxygen

   ______b. Not enough acetylene or oxygen pressure

   ______c. Too much acetylene

   ______d. Loose cutting tip

   ______e. Overheating of cutting tip

   ______f. Bad "O" ring in torch body

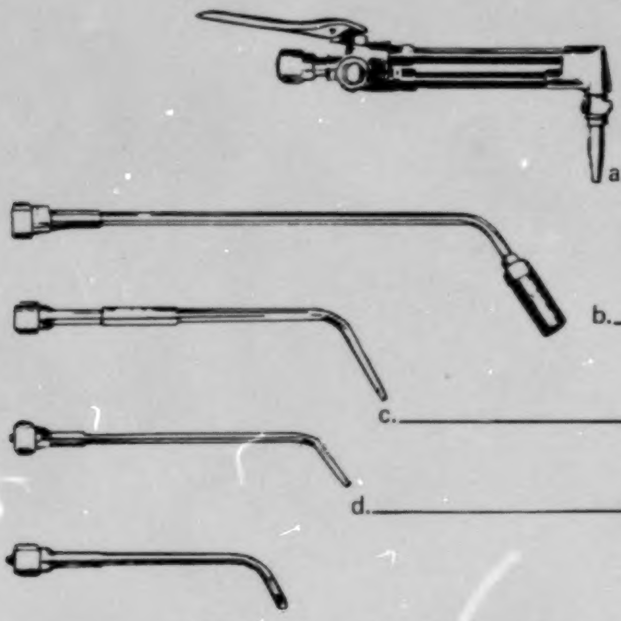
   ______g. Dirty tip

9. Distinguish between flashback and backfire. Write an "F" before flashback and a "B" before backfire in the blanks provided.

   ______a. Flame burns momentarily back into tip; then a loud snap or pop is emitted from the torch and the flame either goes out or continues to burn in a normal manner

   ______b. Flame disappears inside torch body; at the same time, a squealing noise occurs and smoke and/or sparks are emitted from the torch tip

10. Identify a multi-flame heating nozzle (rosebud) and tip from the illustrations below. Mark the correct illustration with an "X."



e. ______________________

11. Describe uses of a multi-flame heating nozzle (rosebud).

____

____

____

12. Demonstrate the ability to:

a. Set up equipment for oxyacetylene cutting.

b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.

c. Cut mild steel at a ninety-degree angle, stop, and restart the cut.

d. Cut round stock.

e. Cut cable.

(NOTE: If the above activities have not been finished before the test, ask your instructor when they should be completed.)

OXYACETYLENE CUTTING
UNIT IV

ANSWERS TO TEST

1. a. 7
   b. 3
   c. 5
   d. 2
   e. 6
   f. 4
   g. 1
   h. 10
   i. 9
   j. 11
   k. 12
   l. 8

2. Any ten of the following:

   a. **Do not** use oil on regulators, torches, fittings, or any place that it may come in contact with oxygen

   b. **Do not confuse oxygen with compressed air**

   c. **Do not** use acetylene at pressures higher than 15 psi

   d. **Do not** leave a burning torch unattended

   e. **Do not** cut or weld directly on gravel or concrete

   f. **Do not** weld on containers that have been used for combustible materials unless they have been cleaned and purged

   g. Secure cylinders to prevent damage to valves and regulators and to prevent injuries

   h. Purge cylinder valve before attaching regulators

   i. Release adjusting screws on regulator before opening cylinder valve

   j. Stand to one side of regulator while slowly opening cylinder valve

   k. Purge oxygen and acetylene passages before lighting torch

   l. Light acetylene gas before opening oxygen valve on torch

   m. Keep heat, flames, and sparks away from combustibles

   n. Use safety goggles, gloves, and protective clothing

   o. Test connections for leaks with Ivory soap and paint brush

   p. Avoid breathing toxic fumes when welding

q. Open torch in a well-ventilated place

r. Weld or cut at least five feet from cylinders

s. Protect hoses from hot metal, rupture, or mechanical damage

3. c. O

e. A

4. a. Oxygen pressure regulating screw

b. Oxygen regulator

c. Oxygen cylinder valve

d. Acetylene regulator

e. Acetylene pressure regulating screw

f. Acetylene cylinder valve

g. Acetylene cylinder

h. Safety chain

i. Oxygen cylinder

j. Cylinder truck

k. Oxygen hose

l. Acetylene hose

m. Acetylene fitting

n. Acetylene torch valve

o. Torch body

p. Tip

q. Oxygen preheat valve

r. Tip nut

s. Cutting attachment

t. Oxygen cutting lever

u. Oxygen fitting

v. Oxygen torch valve

w. Welding goggles

x. Flint lighters

y. Welding gloves

z. Tip cleaners

5. a. Cutting orifice

b. Preheat orifice

c. Tip

d. Tip nut

e. Oxygen cutting lever

f. Acetylene fitting

g. Oxygen preheat valve

h. Acetylene torch valve

i. Torch body

j. Oxygen torch valve

k. Oxygen fitting

6. a. Oxidizing flame

b. Carburizing flame

c. Neutral flame

7. a. 8

b. 4

c. 7

d. 2

e. 1

f. 5

g. 3

h. 6

8. b, d, e, f, g

9. a. B

b. F

10. b

11. Description should include:

Used to heat parts and/or metals, such as bearings, before fitting them to the journal; also used to preheat metal before welding

12. Performance skills evaluated to the satisfaction of the instructor

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to distinguish the basic differences between diesel and gasoline engines. The student should also be able to identify components of basic engines and state their purposes. This knowledge will be evidenced by completion of job sheets and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with basic principles of engines to the correct definitions.
2. Identify basic parts of diesel and gasoline engines.
3. Arrange in order the strokes in a two-stroke or four-stroke engine beginning with intake stroke.
4. Distinguish basic differences between a gasoline engine and a diesel engine.
5. Identify components of a cooling system.
6. Match types of cooling systems to their uses.
7. Select from a list requirements of a good coolant.
8. Describe operation of thermostat when engine is cold and when engine is at operating temperature.
9. Select from a list preventive maintenance procedures.
10. Distinguish between components of fuel systems for gasoline and diesel engines.
11. Match gasoline engine and diesel engine fuel systems to their proper functions.
12. Distinguish among types of air cleaners.
13. Label types of electrical circuits.
14. Select from a list factors that affect resistance in a conductor.
15. Complete Ohm's law chart.
16. Match laws of circuits to their illustrations.

17. Distinguish between direct current and alternating current.

18. State functions of battery.

19. Select from a list processes by which a battery converts chemical energy into electrical energy.

20. Select from a list safety rules pertaining to care and maintenance of batteries.

21. Label components of the starting system.

22. Match major parts of starting circuit to their functions.

23. List components of the ignition system.

24. Arrange in order the operation of ignition system through one complete cycle, beginning with battery.

25. Label major components of an electronic ignition system.

26. Match major components of an electronic ignition system to their functions.

27. Distinguish the purpose of intake system and exhaust system in diesel engines.

28. Distinguish between parts of an intake system and parts of an exhaust system.

29. Distinguish among the three methods of scavenging the cylinders on a two-stroke cycle engine.

30. Distinguish between port and valve scavenging on a two-stroke cycle engine.

31. Distinguish between the two types of superchargers.

32. Select from a list advantages of a turbocharged engine.

33. State purposes of engine lubrication system.

34. Select from a list characteristics of good engine oil.

35. List oil contaminants.

36. Match oil additives to their functions.

37. State general rules for selecting engine oil.

38. Demonstrate the ability to:

    a. Test thermostat action.

    b. Test for exhaust gas leakage and air in cooling system.

    c. Test antifreeze solution.

    d. Service an air cleaner.

e. Clean and service a battery.

f. Remove and replace a battery.

g. Measure battery electrolyte with a hydrometer.

h. Start an engine using a negative-ground booster battery.

i. Use a twenty-four volt (24 V) battery booster system to start a vehicle with a twelve volt (12 V) system.

j. Remove and replace contact points and condenser.

k. Adjust dwell on an externally adjustable distributor.

l. Check and set ignition timing.

m. Remove, service, and replace spark plugs.

n. Change oil in an engine.

o. Change an oil filter.

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Order film(s).

  (NOTE: Engine manufacturers are excellent sources for slide and film presentations on gasoline and diesel engines. Write directly to the appropriate company or manufacturer.)

  B. Provide students with objective sheet.

  C. Provide students with information and job sheets.

  D. Make transparencies.

  E. Discuss unit and specific objectives.

  F. Discuss information sheets.

  G. Check with major engine manufacturers for visual aids to demonstrate basic engine operation.

  H. Demonstrate and discuss procedures outlined in job sheets.

  I. Give test.

II. Instructional materials:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Two-Stroke Cycle Operation (Gasoline and Diesel)
    2. TM 2--Four-Stroke Cycle Operation (Gasoline)
    3. TM 3--Four-Stroke Cycle Operation (Diesel)
    4. TM 4--Cooling System Components (Gasoline)
    5. TM 5--Cooling System Components (Diesel)
    6. TM 6--Thermostat Operation
    7. TM 7--Fuel System Components (Gasoline)
    8. TM 8--Fuel System Components (Diesel)

9. TM 9--Types of Air Cleaners
10. TM 10--Types of Air Cleaners (continued)
11. TM 11--Types of Electrical Circuits
12. TM 12--Current and Electrolyte
13. TM 13--Components of the Starting System
14. TM 14--Major Components of the Ignition System
15. TM 15--Operation of the Ignition System - A
16. TM 16--Operation of the Ignition System - B
17. TM 17--Operation of the Ignition System - C
18. TM 18--Operation of the Ignition System - D
19. TM 19--Operation of the Ignition System - E
20. TM 20--Major Components of the Electronic Ignition System
21. TM 21--Crankcase Scavenging Engine
22. TM 22--Scavenging Pump and Blower
23. TM 23--Port-Scavenged Engine
24. TM 24--Valve-Scavenged Engine
25. TM 25--Positive Displacement Supercharger
26. TM 26--Centrifugal-Type Supercharger

D. Job sheets

1. Job Sheet #1--Test Thermostat Action
2. Job Sheet #2--Test for Exhaust Gas Leakage and Air in Cooling System
3. Job Sheet #3--Test Antifreeze Solution
4. Job Sheet #4--Service an Air Cleaner
5. Job Sheet #5--Clean and Service a Battery
6. Job Sheet #6--Remove and Replace a Battery
7. Job Sheet #7--Measure Battery Electrolyte with a Hydrometer
8. Job Sheet #8--Start an Engine Using a Negative-Ground Booster Battery
9. Job Sheet #9--Use a Twenty-four Volt (24 V) Battery Booster System to Start a Vehicle with a Twelve Volt (12 V) System

10. Job Sheet #10--Remove and Replace Contact Points and Condenser
11. Job Sheet #11--Adjust Dwell on an Externally Adjustable Distributor
12. Job Sheet #12--Check and Set Ignition Timing
13. Job Sheet #13--Remove, Service, and Replace Spark Plugs
14. Job Sheet #14--Change Oil in an Engine
15. Job Sheet #15--Change an Oil Filter

E. Test

F. Answers to test

III. Unit references:

A. Armstrong, Ivan J. and Bundy, Mike. *Specialized Units in Auto Mechanics.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1979.

B. Armstrong, Ivan J. *Auto Mechanics Volume I.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1976.

C. Armstrong, Ivan J. *Auto Mechanics Volume II.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1978.

D. Foutes, William A. *Diesel Engine Mechanics.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1977.

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Compression--Reduction in volume of gases trapped in cylinder by upward motion of piston

B. Cycle--Series of events that repeat themselves in a regular sequence

C. TDC--Top dead center

D. BDC--Bottom dead center

E. Stroke--Distance piston moves when traveling from TDC to BDC

F. Compression ratio--Ratio of whole cylinder volume to clearance volume

Examples: If cylinder volume at TDC is at 45 cubic inches and clearance volume is 5 cubic inches, the compression ratio is

$45 \div 5 = 9$ or 9:1 ratio
$80 \div 4 = 20$ or 20:1 ratio

G. Volume--Total space between piston at BDC and cylinder head

H. Clearance volume--Total space between piston at TDC and cylinder head

I. Coolant--Liquid that circulates through cooling system to transfer engine heat

J. Antifreeze--Substance added to cooling system to lower its freezing point

K. Thermostat--Heat-controlled valve in the cooling system used to regulate the flow of coolant between cylinder block and radiator

L. Pressure cap--Radiator cap which increases pressure within cooling system several psi, allowing coolant to circulate at higher temperatures without evaporation or surge loss

M. psi--Pounds per square inch

N. Atomize--To reduce a liquid to a fine spray

O. Injection nozzle--Device that atomizes fuel and sprays it into combustion chamber

P. Dwell--Number of degrees of distributor cam rotation that ignition points are closed

Q. Viscosity--Measure of ability of an oil to resist flowing

R. SAE--Classification of motor, transmission, or differential lubricants to indicate viscosities standardized by the Society of Automotive Engineers

S. Eccentric--Disc or offset section (of a shaft) used to convert rotary to reciprocating motion (cam)

T. Volt--Unit of potential difference or electromotive force equal to the potential difference between two points for which one coulomb of electricity will do one joule of work in going from one point to another

U. Voltage--Potential difference or electromotive force measured in volts

V. Current--Flow of electric charge

W. Resistance--Property of a conductor by which it opposes the flow of an electric current, resulting in generation of heat in conducting material

X. Conductor--Wire, cable, or other body or medium suitable for carrying electric current

Y. Ohm--Unit of electrical resistance equal to the resistance through which a current of one ampere will flow when there is a potential difference of one volt across it

Z. Coulomb--Charge transported through a conductor by a current of one ampere flowing for one second; this is the legal standard of electricity

AA. Joule--Newton unit of energy; the amount of work done by one newton acting through a distance of one meter and equal to 10,000 ergs

BB. Newton--The unit of force in the mks (meter-kilogram-second) system

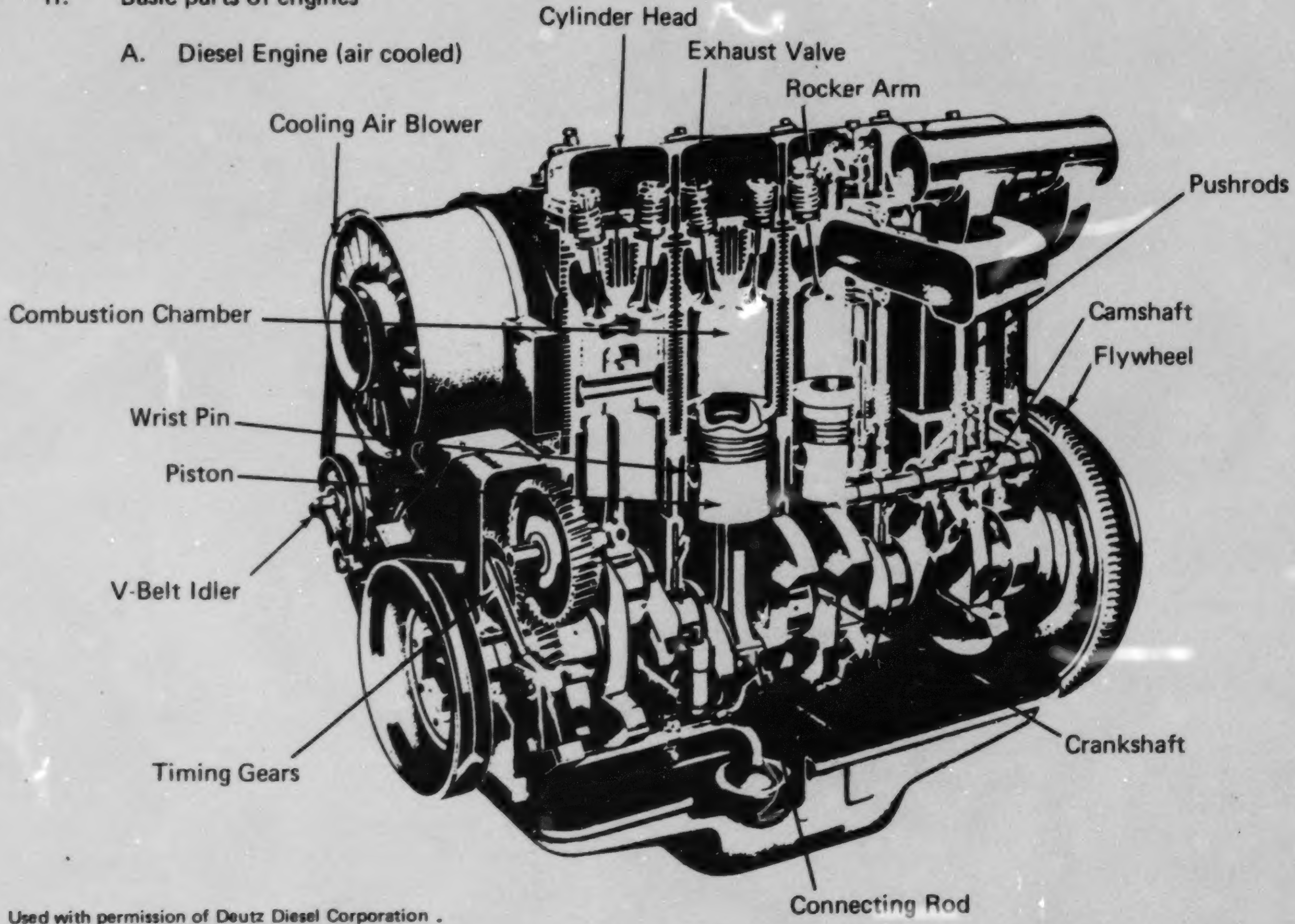
CC. Ampere--Standard unit for measuring the strength of an electric current; rate of flow or charge in a conducting medium of one coulomb per second

DD. Scavenge--Method of pushing air out of the cylinders during the exhaust stroke on two-cycle engines

INFORMATION SHEET

II. Basic parts of engines

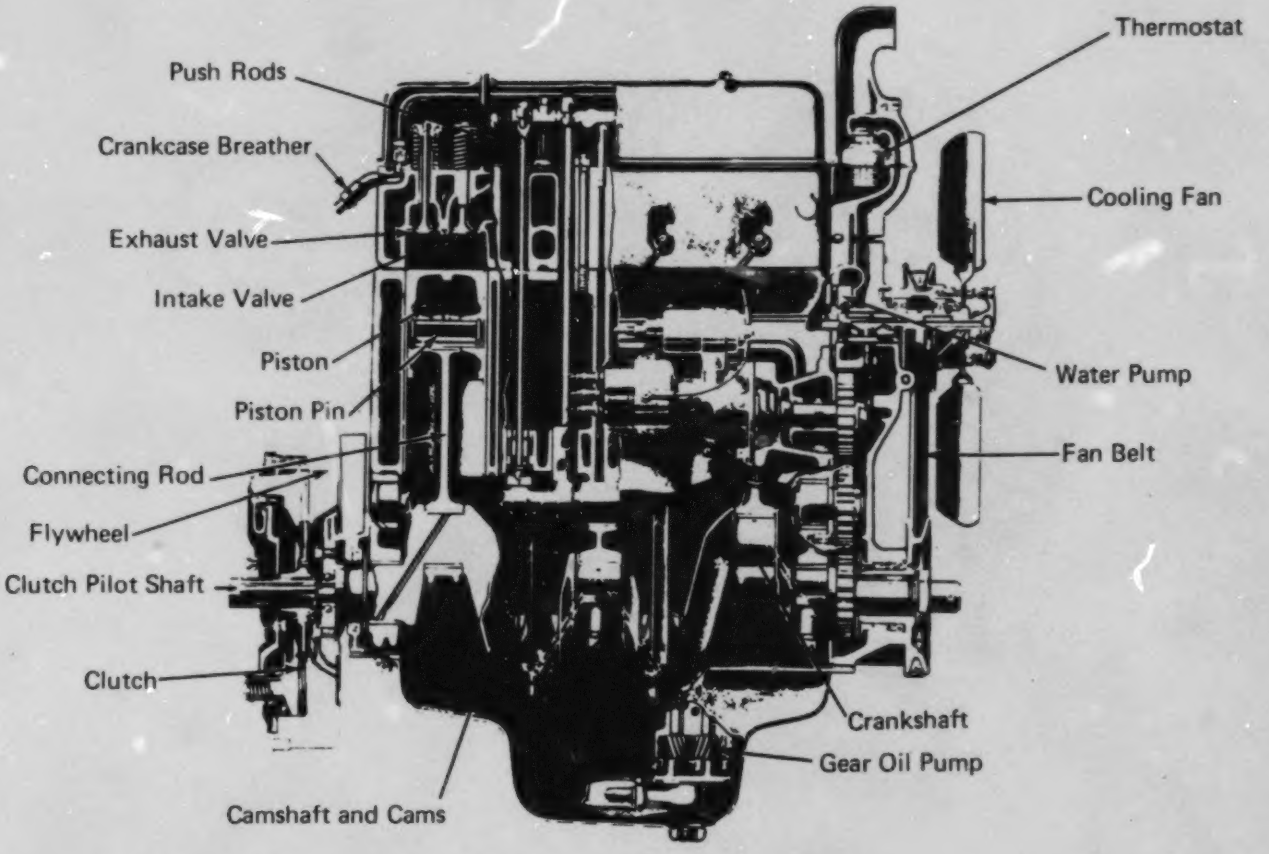
A. Diesel Engine (air cooled)


Cylinder Head
Exhaust Valve
Rocker Arm
Cooling Air Blower
Pushrods
Combustion Chamber
Camshaft
Flywheel
Wrist Pin
Piston
V-Belt Idler
Crankshaft
Timing Gears
Connecting Rod

Used with permission of Deutz Diesel Corporation.

INFORMATION SHEET

B. Gasoline engine (industrial)


Push Rods
Crankcase Breather
Exhaust Valve
Intake Valve
Piston
Piston Pin
Connecting Rod
Flywheel
Clutch Pilot Shaft
Clutch
Camshaft and Cams
Thermostat
Cooling Fan
Water Pump
Fan Belt
Crankshaft
Gear Oil Pump

Used with permission of International Harvester Company.

INFORMATION SHEET

III. Strokes in a two-stroke or four-stroke engine (Transparencies 1, 2, and 3)

(NOTE: Two-stroke and four-stroke refer to the number of times the piston travels up and down in the cylinder to complete one cycle of operation.)

A. Intake

B. Compression

C. Power (ignition)

D. Exhaust

IV. Basic differences between gasoline and diesel engines

A. Gasoline

1. Ignition by electrical spark
2. Takes fresh air and fuel through carburetor, and then to combustion chamber
3. Low compression ratio (7-12:1)
4. Burns gasoline

B. Diesel

1. Ignition by compression
2. Takes fresh air directly to combusion chamber
3. High compression ratio (16-22:1)
4. Burns low-grade fuel oil

V. Components of a cooling system (Transparencies 4 and 5)

(NOTE: The purpose of the cooling system is to keep the engine at its most efficient operating temperature during all engine speeds and driving conditions.)

A. Radiator

B. Radiator hose

C. Water pump

D. Thermostat

E. Engine water jacket

F. Pressure cap

INFORMATION SHEET

- G. Fan (may be reversible in diesel system)
- H. Fan belt
- I. Bypass
- J. Coolant
- K. Air flow

VI. Types of cooling systems

- A. Liquid--Uses circulating coolant
- B. Air--Uses a fan

VII. Requirements of a good coolant

- A. Prevents freezing (water coolant only)
- B. Inhibits rust and corrosion
- C. Chemically stable
- D. Non-conductor of electricity
- E. Flows readily at all temperatures
- F. Conducts heat readily
- G. Resists foaming
- H. Provides lubrication for water pump seal

VIII. Thermostat operation (Transparency 6)

- A. Engine cold--Thermostat shuts off flow of coolant from engine to radiator to allow quicker engine warm-up
- B. Engine at operating temperature--Thermostat is open and allows coolant to circulate through system

IX. Preventive maintenance procedures

- A. Inspect for system deterioration

  (NOTE: Pressure test cooling system but *do not* exceed pressure cap limits.)
- B. Check hose and connections periodically
- C. Flush and clean system periodically

INFORMATION SHEET

D. Lubricate water pump and fan, as required

E. Allow a hot engine to idle a few minutes before shutting it down

(NOTE: Idle speed allows temperatures of parts to equalize and prevents after-boil of coolant.)

F. Check coolant as recommended in operator's manual

G. Check drive belts periodically

X. Fuel system components for gasoline and diesel engines (Transparencies 7 and 8)

(NOTE: The purpose of fuel system is to supply fuel to operate engine to meet all driving conditions.)

A. Fuel tank

B. Fuel filter

C. Fuel pump

D. Carburetor (gasoline engine)

E. Air cleaner (gasoline engine)

F. Fuel injection pump (diesel engine)

G. Fuel injection nozzle (diesel engine)

H. Fuel lines

XI. Functions of gasoline and diesel engine fuel systems

A. Gasoline--Pumps fuel from tank through filters into carburetor where it is mixed with air in proper proportion for a combustible mixture and then delivered to cylinders

B. Diesel--Pumps fuel at low pressure from tank through filters to injection pump where it times the fuel delivery and measures and delivers fuel under pressure to injection nozzle where it is atomized and sprayed into combustion chamber

XII. Types of air cleaners (Transparencies 9 and 10)

A. Dry element--Cleans by replacing element

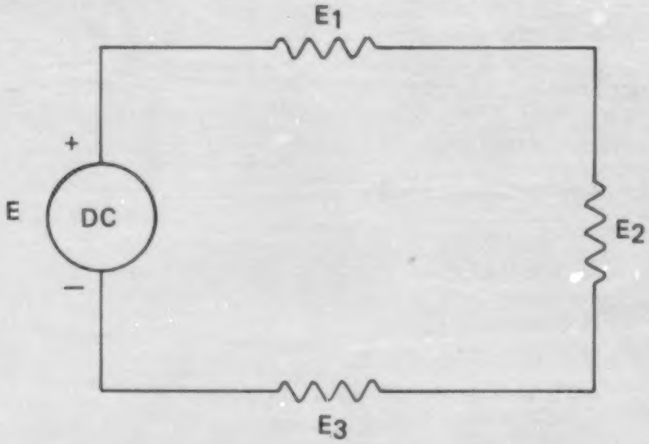
B. Viscous-impingement--Cleans by passing air through a maze of metal wool, wire, or screens saturated with oil

C. Oil bath--Cleans by directing air through a center tube into inner oil cup where direction of air flow is reversed causing most dirt to become trapped by the oil and settle in the sump

INFORMATION SHEET

XIII. Types of electrical circuits (Transparency 11)

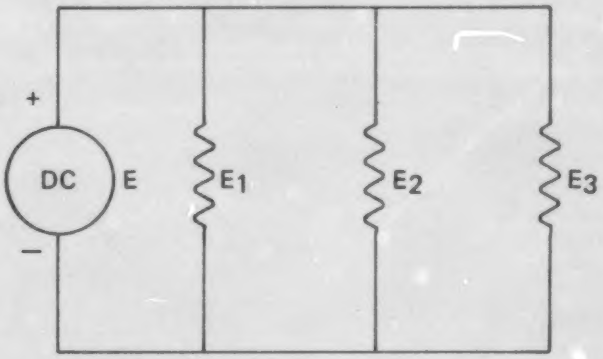
A. Series



$$E = E_1 + E_2 + E_3 + \ldots.$$

(NOTE: In a series circuit, the sum of the voltages across the several parts is equal to the total voltage applied to the circuit.)

B. Parallel

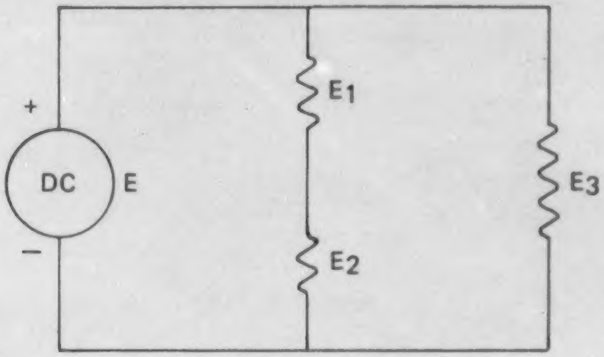


$$E = E_1 = E_2 = E_3 = \ldots$$

(NOTE: The voltage across each branch of a parallel combination is the same as the voltage applied to the entire combination.)

INFORMATION SHEET

C. Series--Parallel



$E = E^1 + E^2$ or $= E^3$

(NOTE: This circuit is a combination of a series circuit and a parallel circuit. It has medium resistance.)

XIV. Factors affecting resistance in a conductor

A. Material

B. Cross-sectional area

C. Length

D. Temperature

INFORMATION SHEET

XV. Ohm's law

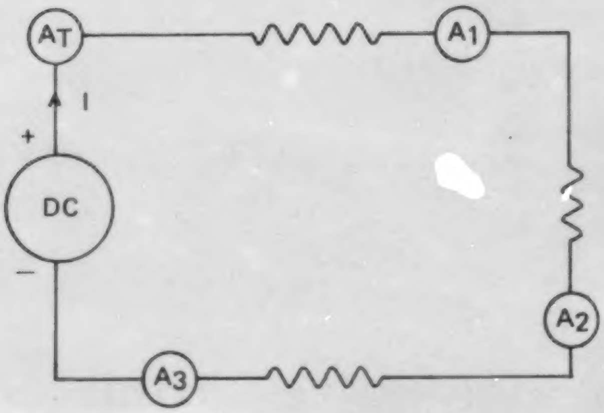
(NOTE: There are three forms of Ohm's law; each is summarized in the chart below.)

Current = $\frac{\text{Voltage}}{\text{Resistance}}$	$I = \frac{E}{R}$	Amperes = $\frac{\text{Volts}}{\text{Ohms}}$
Voltage = Current x Resistance	$E = IR$	Volts = Amperes x Ohms
Resistance = $\frac{\text{Voltage}}{\text{Current}}$	$R = \frac{E}{I}$	Ohms = $\frac{\text{Volts}}{\text{Amperes}}$

XVI. Laws of series and parallel circuits

A. Series

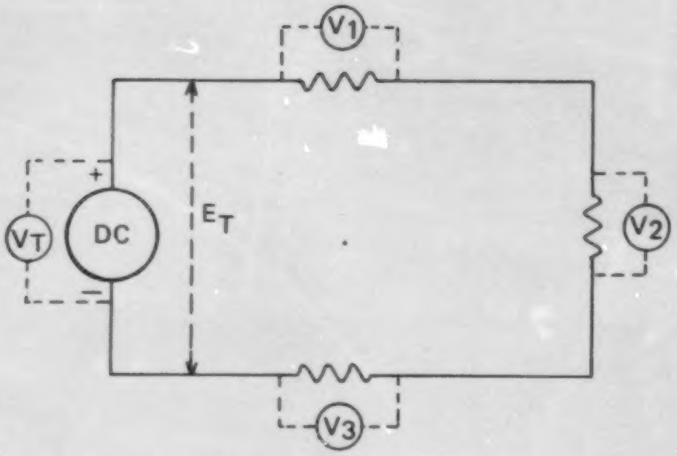
1. Current--Current is the same in all parts of circuit



A = Ammeter
$A_T = A_1 = A_2 = A_3 = \ldots$
$I_T = I_1 = I_2 = I_3 = \ldots$
I = Current in amps

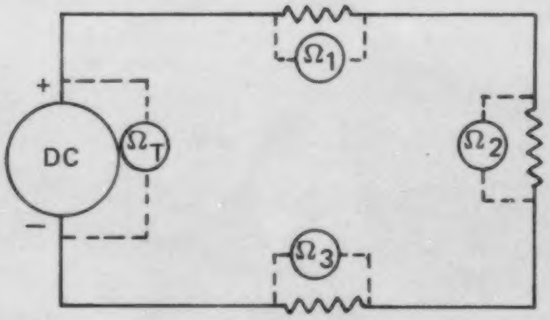
INFORMATION SHEET

2. Voltage--Total voltage equals sum of voltages across different parts of the circuit


V_1
+
V_T
DC
−
E_T
V_2
V_3

V = Voltmeter
$V_T = V_1 + V_2 + V_3 + \ldots$
$E_T = E_1 + E_2 + E_3 + \ldots$
E = Voltage

3. Resistance--Total resistance equals sum of resistances of the separate parts

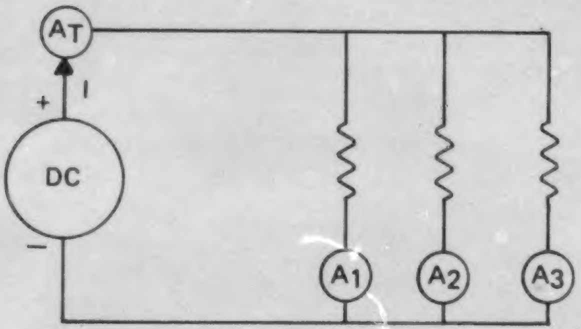

Ω_1
+
DC
Ω_T
−
Ω_2
Ω_3

Ω =Ohmmeter
$\Omega_T = \Omega_1 + \Omega_2 + \Omega_3 + \ldots$
$R_T = R_1 + R_2 + R_3 + \ldots$
R = Resistance in Ohms

INFORMATION SHEET

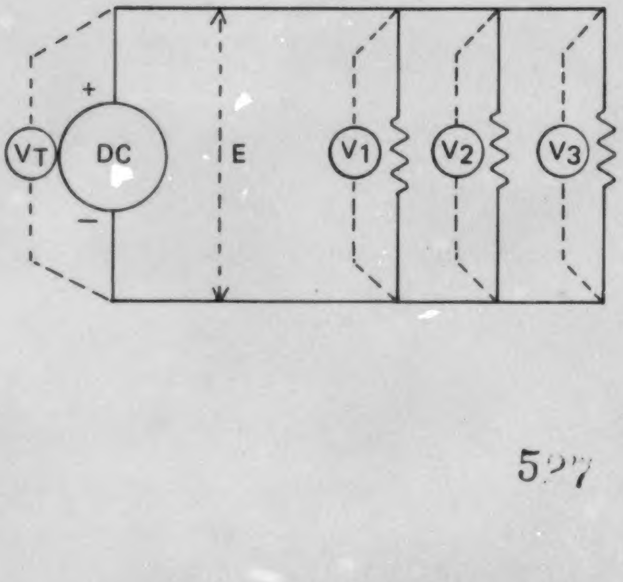
B. Parallel

1. Current--Total current supplied to circuit equals sum of currents through the several branches



A = Ammeter
$A_T = A_1 + A_2 + A_3 + \ldots$
$I_T = I_1 + I_2 + I_3 + \ldots$
I = Current in amps

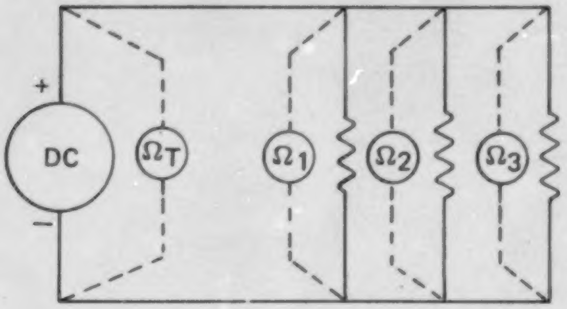
2. Voltage--Voltage across a parallel combination is same as the voltage across each branch



V = Voltmeter
$V_T = V_1 = V_2 = V_3 = \ldots$
$E_T = E_1 = E_2 = E_3 = \ldots$
E = Voltage

INFORMATION SHEET

3. Resistance--Reciprocal of equivalent or combined resistance equals sum of the reciprocals of resistances of individual branches



Ω= Ohmmeter
$\Omega_T = \Omega_1 + \Omega_2 + \Omega_3 + \ldots$
$R_T = R_1 + R_2 + R_3 + \ldots$
R = Resistance in Ohms

XVII. Direct and alternating current

- A. Direct current (DC)
  - 1. Supplied by
    - a. Generator
    - b. Battery (dry and wet cell)
  - 2. Flows in one direction only
- B. Alternating current (AC)
  - 1. Supplied by alternating current generator (alternator)
  - 2. Flows in one direction; then reverses and flows in the opposite direction

XVIII. Functions of a battery

- A. Supplies current for cranking engine
- B. Supplies current when demand exceeds output of charging system
- C. Stabilizes voltage in system during operation

INFORMATION SHEET

XIX. Converting chemical energy into electrical energy (Transparency 12)

A. Two dissimilar metals placed in acid solution will produce chemical action

B. More active metal will lose electrons and become positively charged

C. Less active metal will accumulate electrons and become negatively charged

XX. Safety rules pertaining to care and maintenance of batteries

A. Wear safety glasses, rubber gloves, and rubber apron when servicing batteries

B. Do not allow electrolyte to come in contact with eyes, skin, clothing, or painted surfaces

C. Flush immediately with water any area of skin which acid has contacted

D. Avoid breathing fumes from battery

E. Keep flames or sparks away from battery because gases given off by battery are very explosive

(NOTE: Gases given off are hydrogen and oxygen.)

F. Avoid shorting or grounding battery terminals during service

XXI. Components of the starting system (Transparency 13)

(NOTE: In order to crank the engine, the starting system converts electrical energy from battery into mechanical energy at the starter.)

A. Battery

B. Key switch

C. Starter switch

D. Starter

E. Small gage switch wire

F. Battery cable

G. Solenoid

XXII. Functions of parts of the starting circuit

A. Battery--Supplies energy for the circuit

B. Starter switch--Activates the circuit

INFORMATION SHEET

C. Motor switch--Closes circuit to motor and engages motor drive with flywheel

D. Starting motor--Drives flywheel to start engine

XXIII. Components of ignition system (Transparency 14)

(NOTE: Ignition system provides a high spark to ignite fuel-air mixture in the combustion chamber.)

A. Battery

B. Ignition switch

C. Primary resistance unit

D. Ignition coil

E. Contact points (breaker points)

F. Condenser

G. Distributor

H. Breaker cam

I. Spark advance mechanism

(NOTE: There are two types of spark advance mechanisms, vacuum and mechanical. Engine vacuum controls timing advance in relating to engine load. Mechanical advance changes engine timing according to engine speed.)

J. Rotor

K. Distributor cap

L. Spark plug

M. Primary ignition wire

N. Secondary ignition wire

XXIV. Operation of the ignition system through one complete cycle (Transparencies 15, 16, 17, 18, and 19

A. With the ignition switch on and the contact points closed, low voltage current flows from the battery through the primary winding of the coil and through the contact points to ground (Transparency 15)

B. The flow of low voltage current through the primary windings of the coil causes a magnetic field build-up (Transparency 16)

INFORMATION SHEET

C. As the contact points open, current continues to flow across the point surfaces; the condenser attached to the points absorbs this flow of current (Transparency 17)

D. Stopping this flow of current causes the magnetic field of the coil primary windings to collapse across the secondary coil windings, causing a high voltage surge (Transparency 18)

E. This high voltage surge is directed from the secondary windings of the coil through the distributor cap and rotor and on to the spark plug to ground (Transparency 19)

XXV. Major components of an electronic ignition system (Transparency 20)

A. Duel ballast resistor

(NOTE: This component is not used in all models.)

B. Control unit

C. Magnetic pickup assembly

D. Armature or reluctor

E. Distributor

F. Ignition coil

XXVI. Function of major components of electronic ignition system

A. Dual ballast resistor--Maintains constant primary current with variations in engine speed

(NOTE: Dual ballast resistor is bypassed during engine starting.)

B. Magnetic pickup assembly--Sends a small voltage pulse to control unit which triggers switching transistor to stop current flow in the coil primary windings

C. Armature or reluctor--Rotates with the distributor shaft, producing a voltage pulse in the magnetic pickup

(NOTE: The armature contains the same number of tips as the engine contains cylinders.)

D. Control unit--Controls the flow of current in the primary windings of the ignition coil and maintains constant dwell

XXVII. Purpose of air intake and exhaust system

A. Air intake system--To supply air (oxygen) for burning the fuel in the combustion chamber

INFORMATION SHEET

B. Exhaust system--To scavenge exhaust gases efficiently from the combustion chamber and conduct them to the outside air with a minimum of noise

XXVIII. Parts of an air intake system and an exhaust system

A. Air intake system

1. Precleaner (air cleaner)
2. Supercharger (if used)
3. Intake manifold
4. Piping
5. Intake valves or ports

B. Exhaust system

1. Ports and/or valves
2. Exhaust manifold
3. Piping
4. Turbocharger (if used)

(NOTE: If engine is equipped with a supercharger, its compressor is part of the intake system. If engine is equipped with a turbocharger, its compressor is part of the intake system and its turbine is part of the exhaust system.)

XXIX. Methods of scavenging the cylinders on a two-stroke cycle engine

A. Crankcase (Transparency 21)

1. Air enters engine through crankcase
2. Each downward movement of the piston compresses the vapor within crankcase until intake port or valves open
3. The compressed vapor escapes into the cylinder at a pressure nearly equal to atmospheric pressure

B. Power piston (Transparency 22)

1. Uses a separate piston and cylinder driven by engine crankshaft
2. Pushes the vapor into cylinder as intake valves or ports open

C. Blower (Transparency 23)

1. Uses a positive-displacement, rotary blower driven by the engine
2. Compresses the vapor into air chamber surrounding intake ports

INFORMATION SHEET

XXX. Port and valve scavenging on a two-stroke cycle engine

- A. Port scavenging--Air enters and gas leaves through ports in the cylinder block or liner which the piston uncovers (Transparency 23)
- B. Valve scavenging--Air enters through ports in the cylinder block, and gases leave through valves in the cylinder head (Transparency 24)

  (NOTE: The scavenging process in the two-cycle engine uses a swish of air to push out the spent gases, and replaces them with fresh air at atmospheric pressure.)

XXXI. Types of superchargers

- A. Positive-displacement (Transparency 25)

  (NOTE: The Roots blower is a positive-displacement supercharger.)

  1. Driven by a chain, belt, or gear
  2. Resembles oil pump in design
- B. Centrifugal (Transparency 26)

  (NOTE: Turbochargers are an exhaust-driven, centrifugal-type supercharger.)

  1. Driven by engine, engine exhaust, or separate motor
  2. Impeller normally moves thirty times engine speed

XXXII. Advantages of a turbocharged engine

- A. Increases horsepower output of a given displacement engine
- B. Reduces weight by delivering more horsepower per pound than nonturbocharged engines
- C. Cost of a turbocharged engine is less on a dollar-per-horsepower basis
- D. Maintains horsepower at high altitudes

  (NOTE: Naturally aspirated engines lose three percent of horsepower per each one thousand feet of altitude.)
- E. Reduces exhaust smoke by supplying excess air to reduce exhaust density

XXXIII. Purposes of engine lubrication system

- A. Lubricates moving parts to minimize friction
- B. Acts as cooling agent to remove heat from moving parts
- C. Forms a seal between piston rings and cylinder walls

INFORMATION SHEET

D. Keeps parts clean

E. Absorbs shock between bearings and other parts

XXXIV. Characteristics of good engine oil

A. Keeps a protective film on moving parts

B. Resists breakdown at high temperatures

C. Resists corrosion and rusting

D. Prevents carbon build-up

E. Prevents sludge formation

F. Flows easily at low temperatures

G. Resists foaming

H. Resists breakdown after long use

XXXV. Oil contaminants

A. Foreign particles

B. Water

C. Antifreeze

D. Fuel

E. Oxidation

XXXVI. Oil additives and their functions

(NOTE: Most oils already have these additives.)

A. Anti-corrosion--Helps prevent failure of alloy bearings from corrosive acids caused by combustion

B. Oxidation inhibitor--Prevents acid, varnish, and sludge formation

(NOTE: Oxidation causes oil to thicken.)

C. Anti-rust--Prevents rusting of metal parts during storage or down-time

D. Viscosity index improver--Helps oil give top lubricating protection at both high and low temperatures

E. Pour point depressant--Prevents wax crystals from congealing in cold weather and forming clumps

INFORMATION SHEET

F. Detergent-dispersant--Helps keep metal surfaces clean, and prevents deposit formation

G. Foam inhibitor--Helps prevent air bubbles which would resist lubrication

(NOTE: Fast circulation causes oil to foam.)

XXXVII. General rules for selecting engine oil

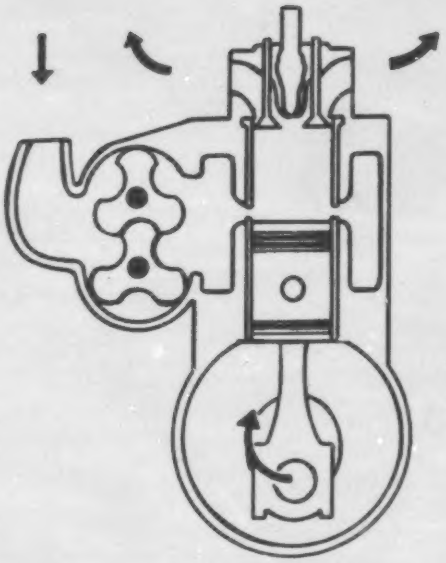
A. Use brands of proper service rating recommended by manufacturer

B. Select brands that have been service tested

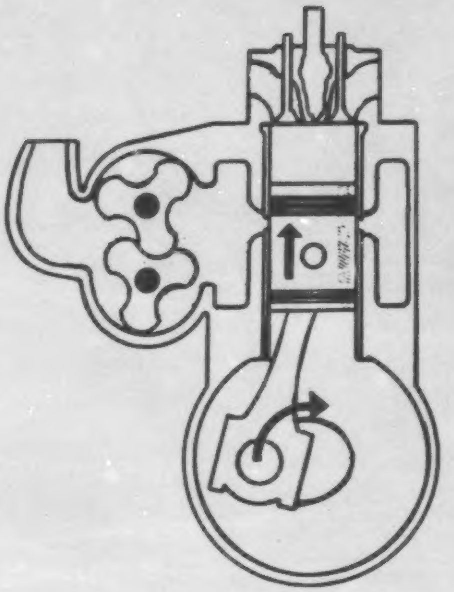
C. Never mix oils of various SAE or viscosity ratings

D. Use oil of proper viscosity for average temperature at which the vehicle will operate

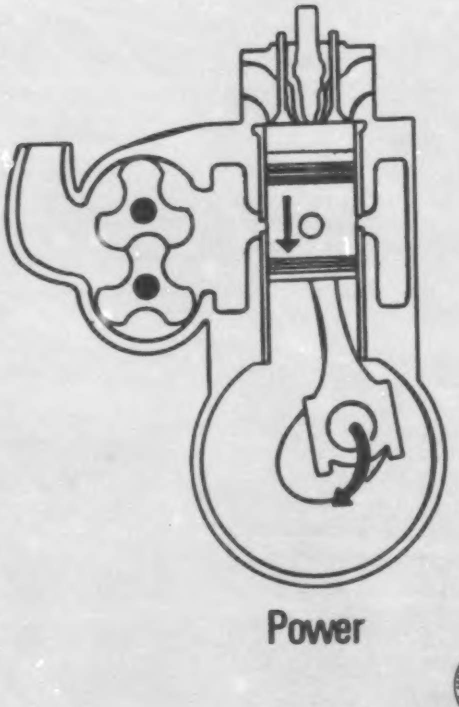
Two-Stroke Cycle Operation (Gasoline and Diesel)



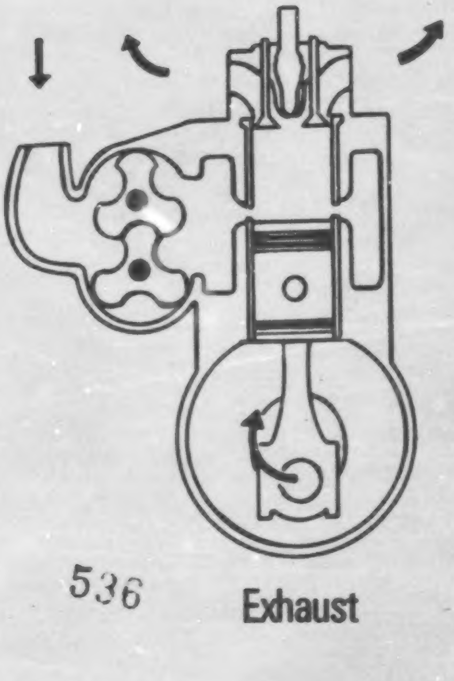
Intake



Compression

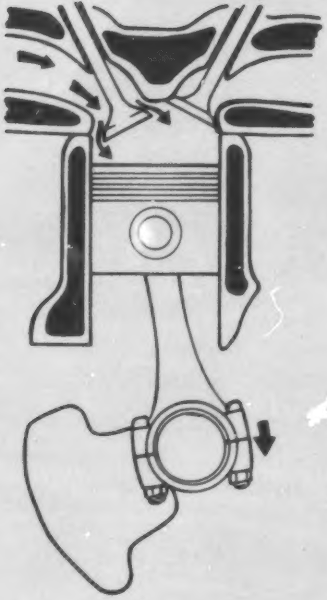


Power

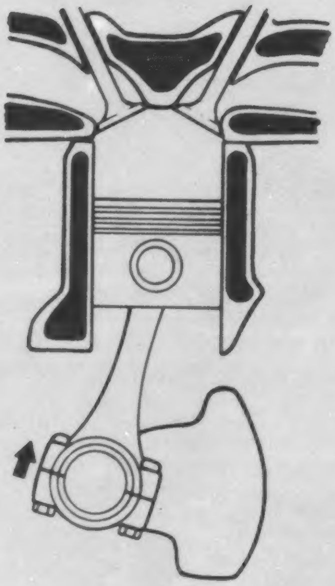


Exhaust

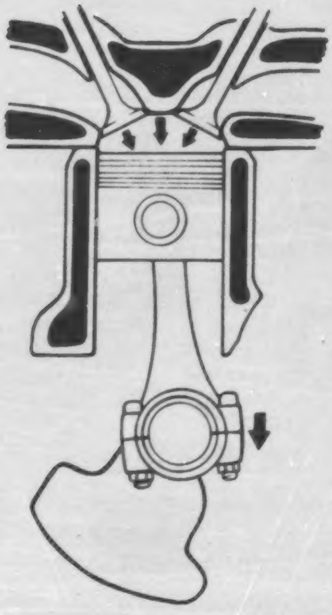
Four-Stroke Cycle (Gasoline)



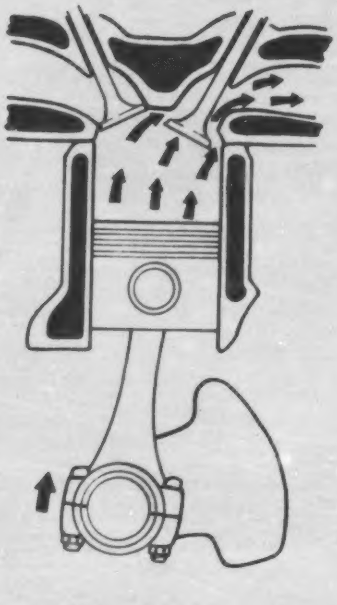
Intake



Compression

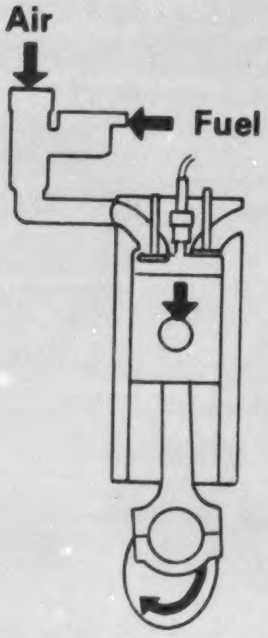


Power

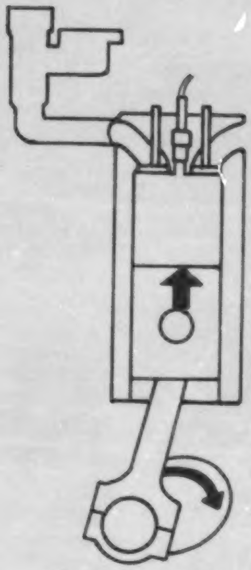


Exhaust

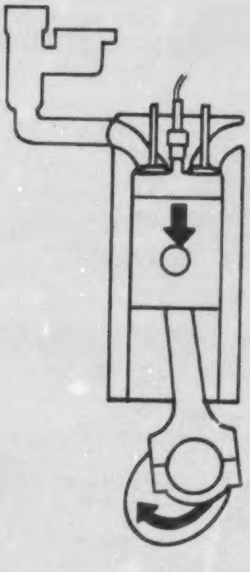
Four Stroke Cycle Operation
(Diesel)



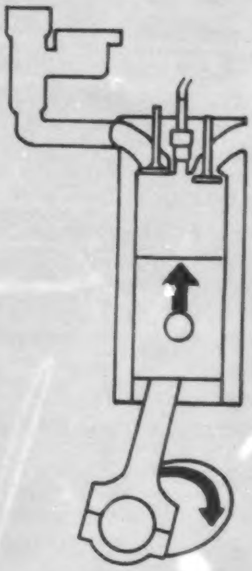
Intake



Compression

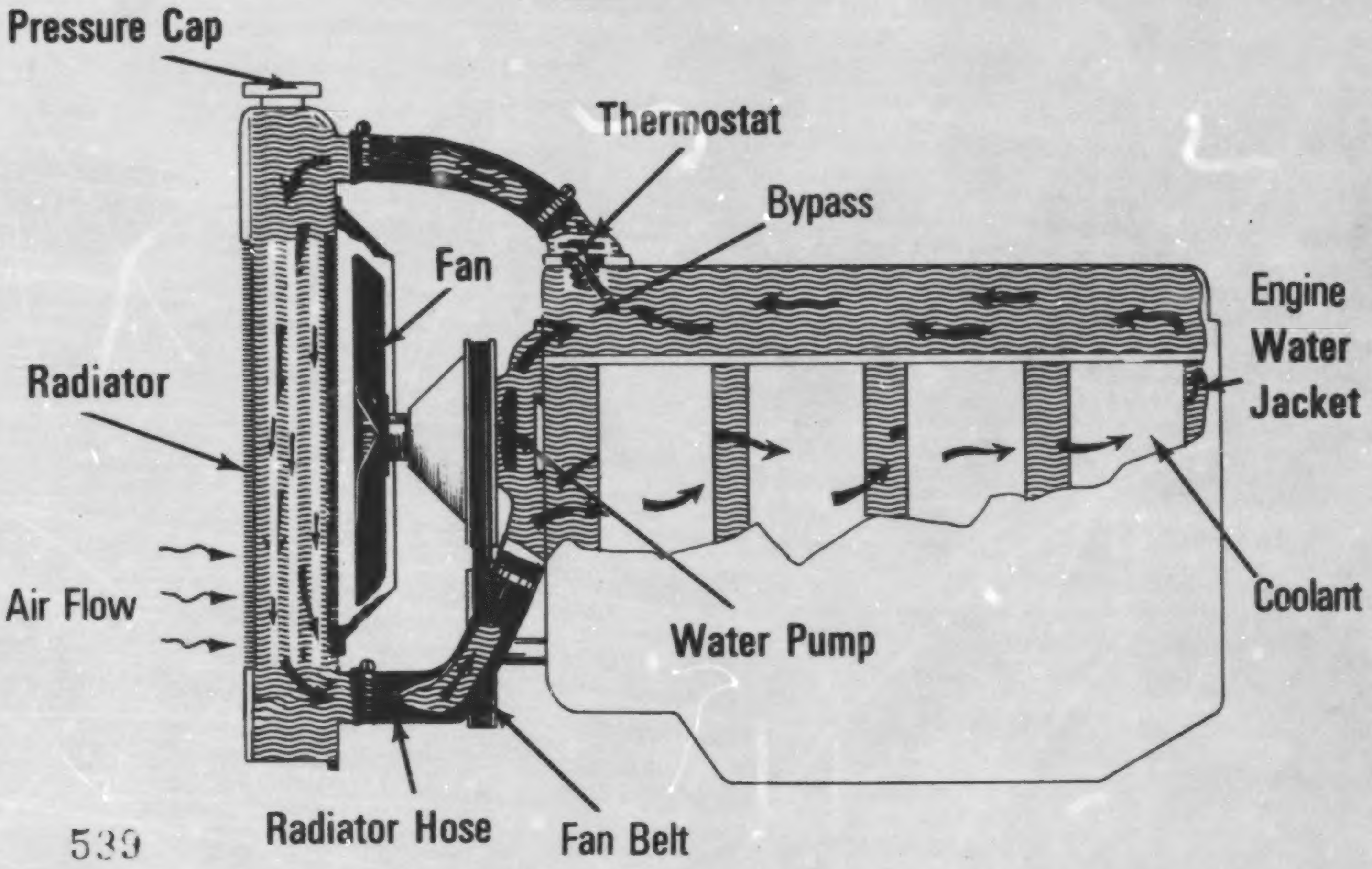


Power



Exhaust

Cooling System Components
(Gasoline)


Pressure Cap
Thermostat
Bypass
Fan
Engine Water Jacket
Radiator
Air Flow
Coolant
Water Pump
Radiator Hose
Fan Belt

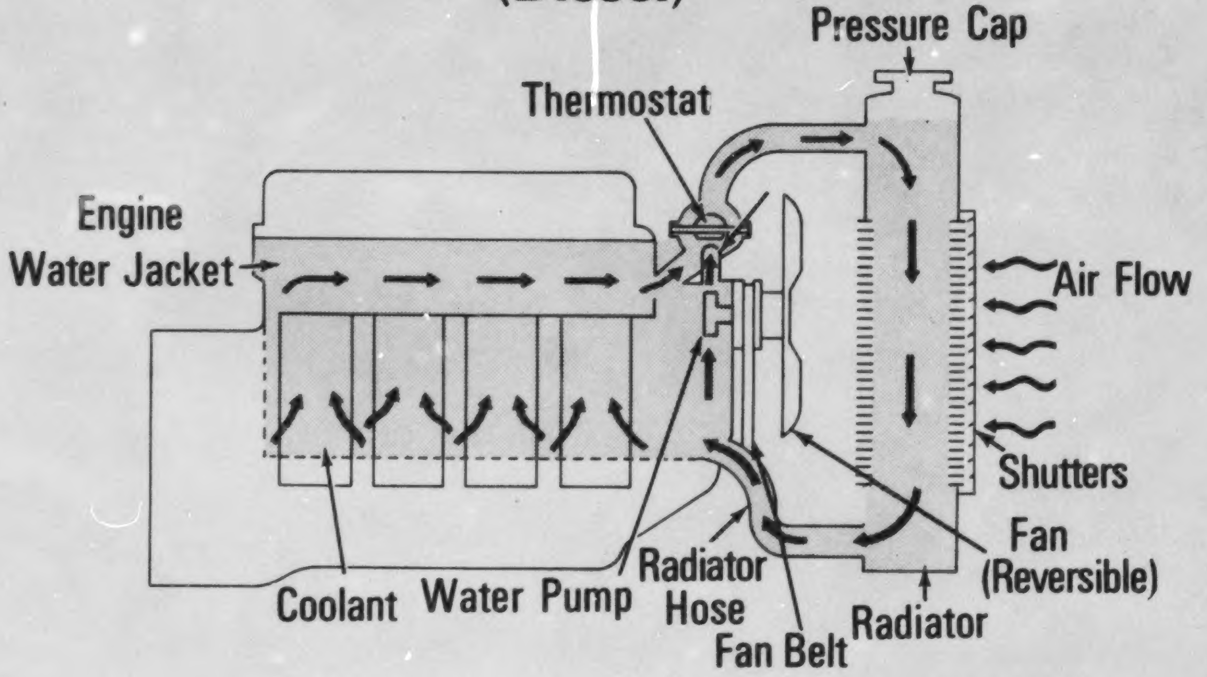
539

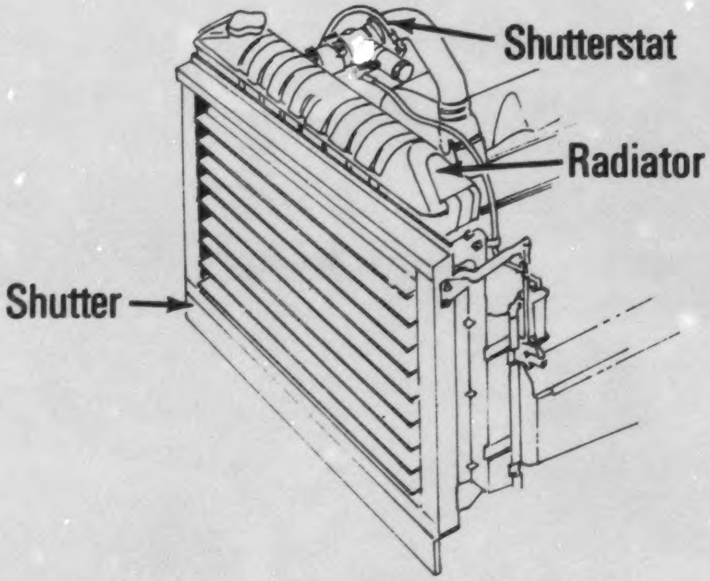
TM 4

540

HEO I - 35-D

Cooling System Components (Diesel)

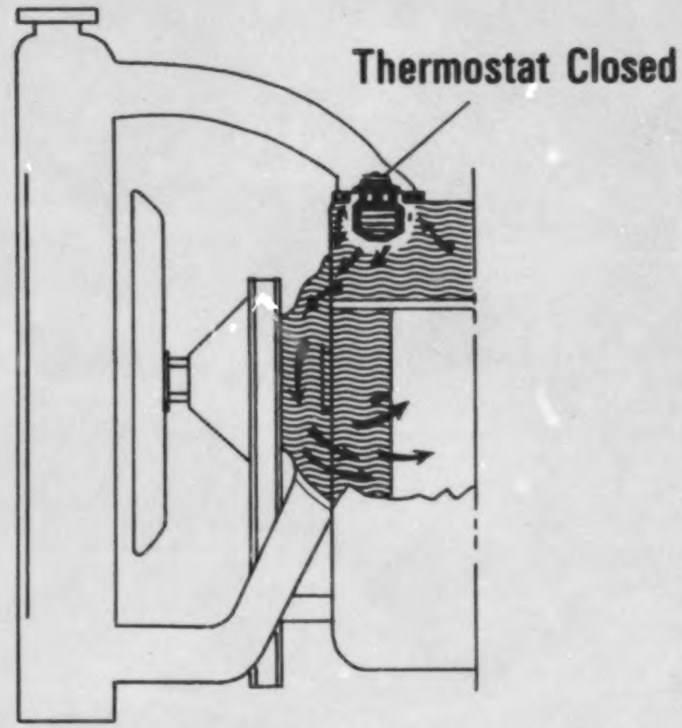

Pressure Cap
Thermostat
Engine Water Jacket
Air Flow
Shutters
Fan (Reversible)
Radiator
Fan Belt
Radiator Hose
Water Pump
Coolant


Shutterstat
Radiator
Shutter

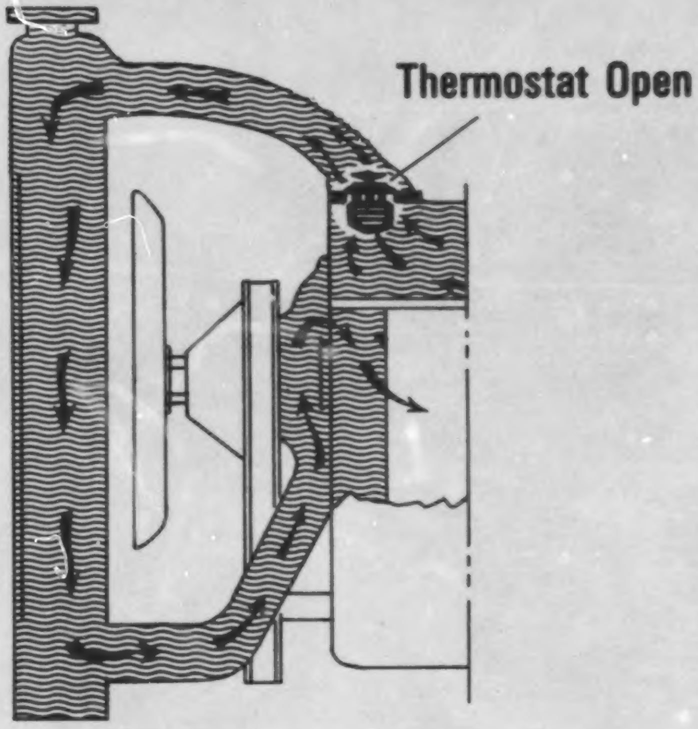
Typical Air Operated Shutter Assembly

541

Thermostat Operation


Thermostat Closed

Engine Cold


Thermostat Open

Engine at Operating Temperature

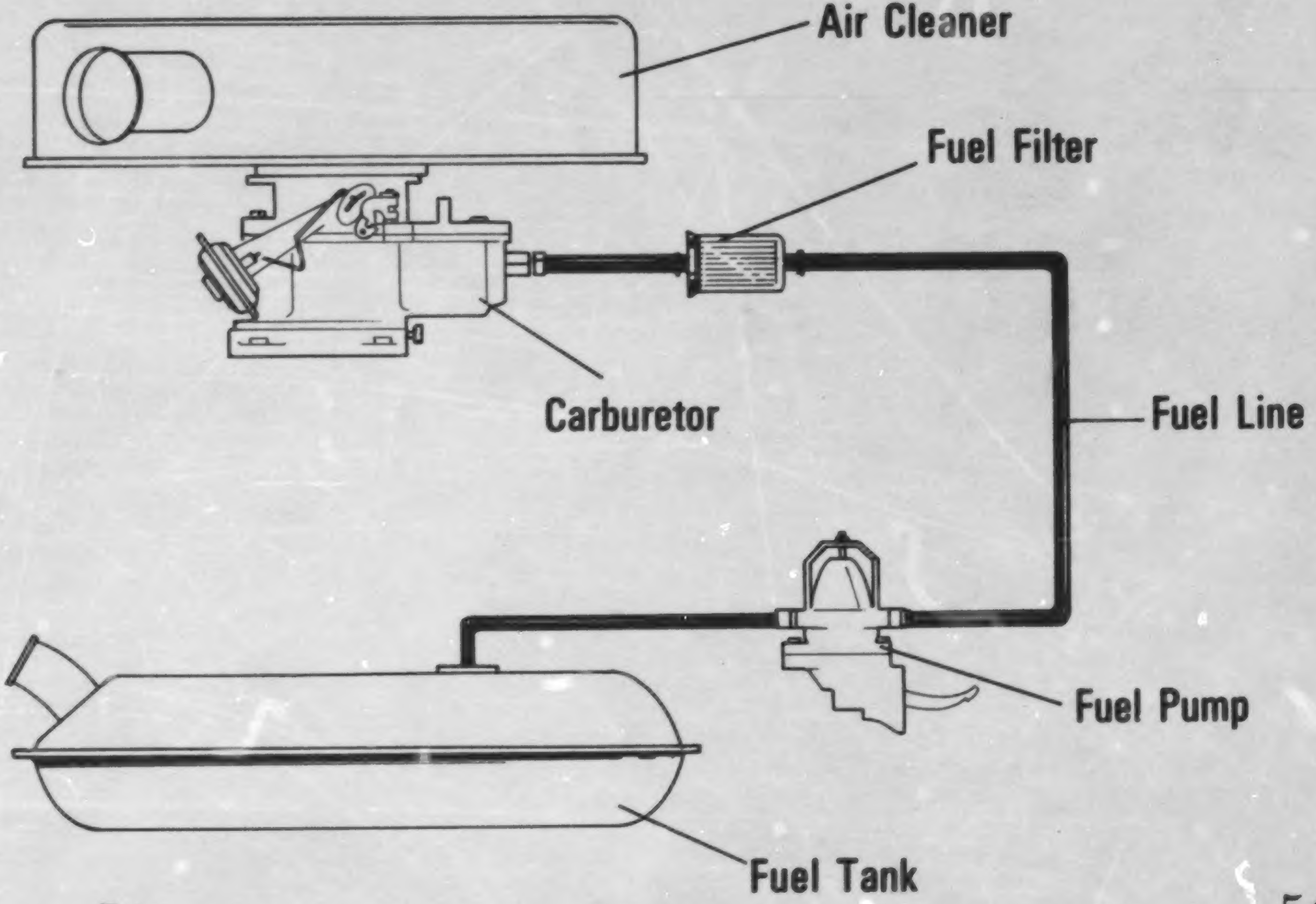
TM 6

542

HEO I - 39-D

543

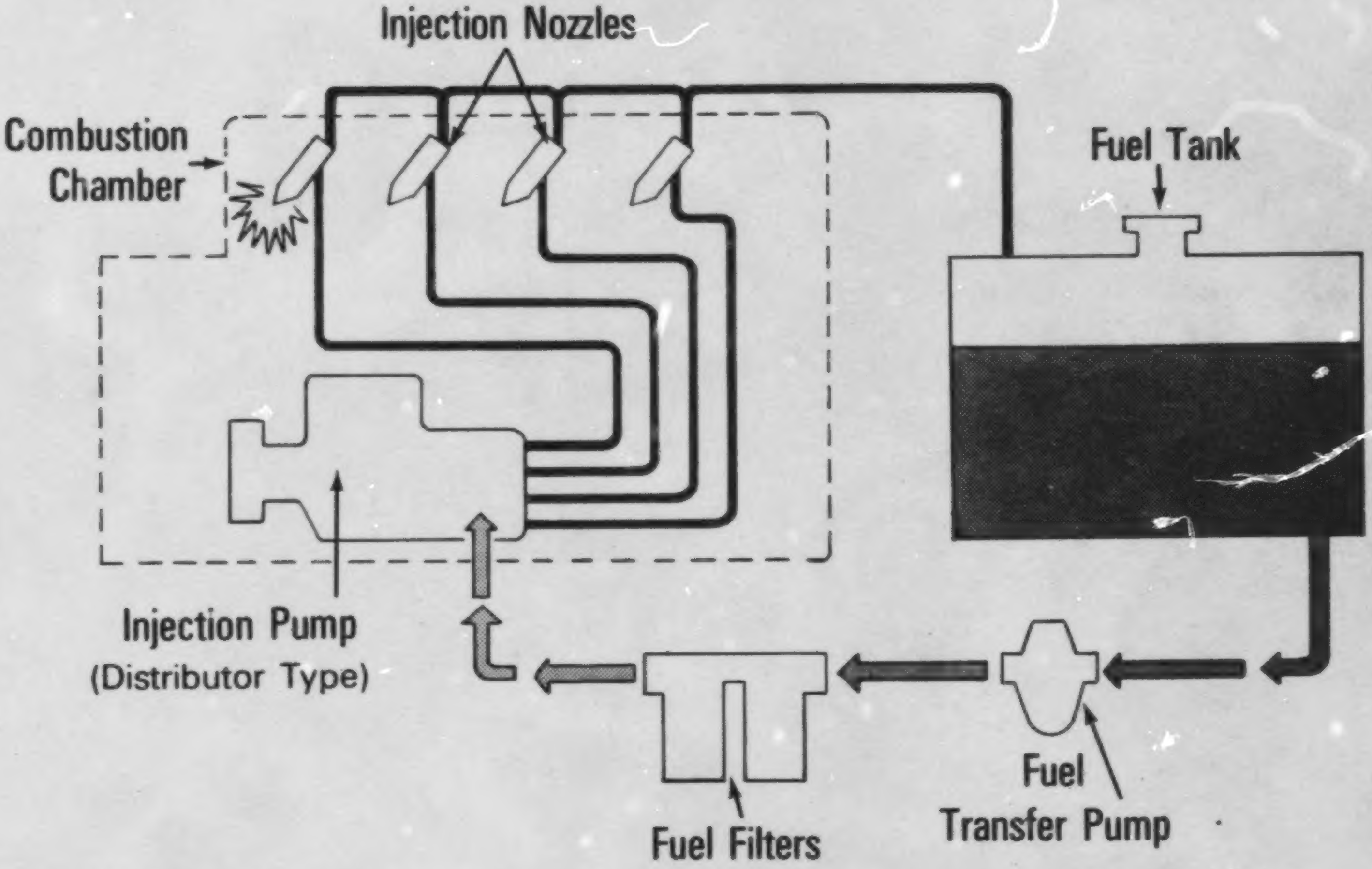
Fuel System Components (Gasoline)


Air Cleaner
Fuel Filter
Carburetor
Fuel Line
Fuel Pump
Fuel Tank

TM 7

HEO1-41-D

Fuel System Components
(Diesel)

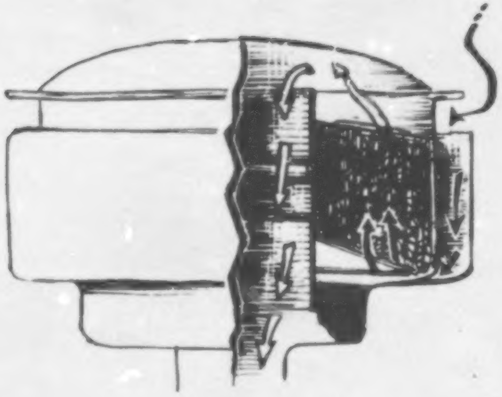

Injection Nozzles
Combustion Chamber
Fuel Tank
Injection Pump (Distributor Type)
Fuel Filters
Fuel Transfer Pump

Used with permission of the Mid-America Vocational Curriculum Consortium

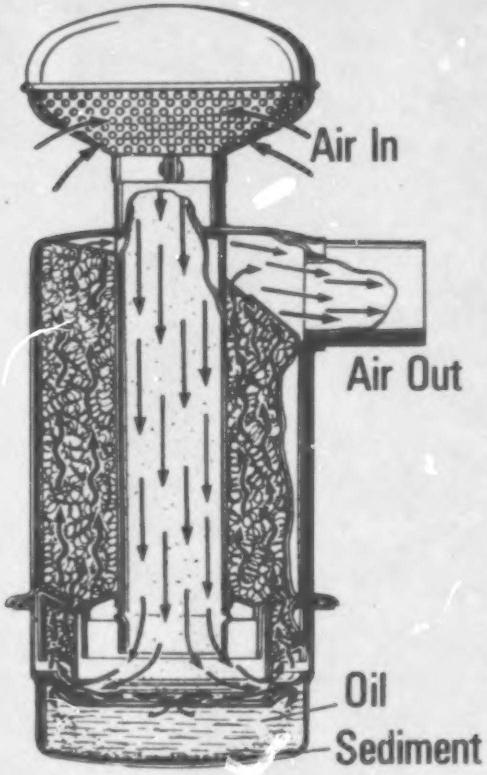
TM 8

HEO I - 43-D

Types of Air Cleaners



Oil Bath


Air In
Air Out
Oil
Sediment

Oil Bath Air Cleaner

Used with permission of the Waukesha Engine Division, Dresser Industries, Inc.

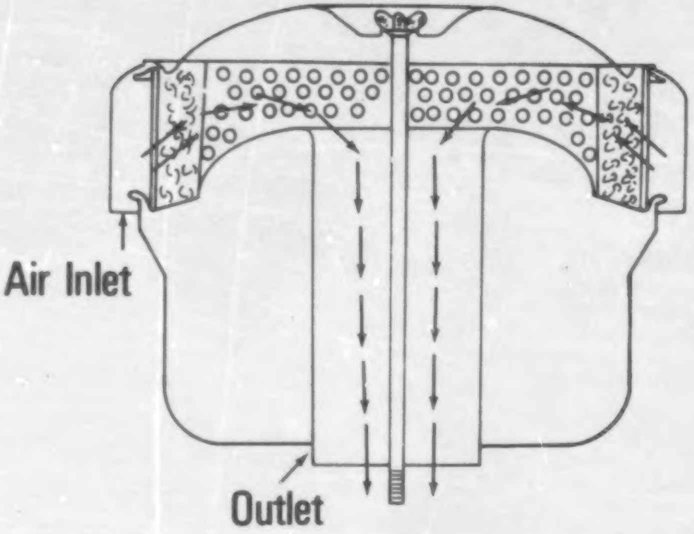
TM 9

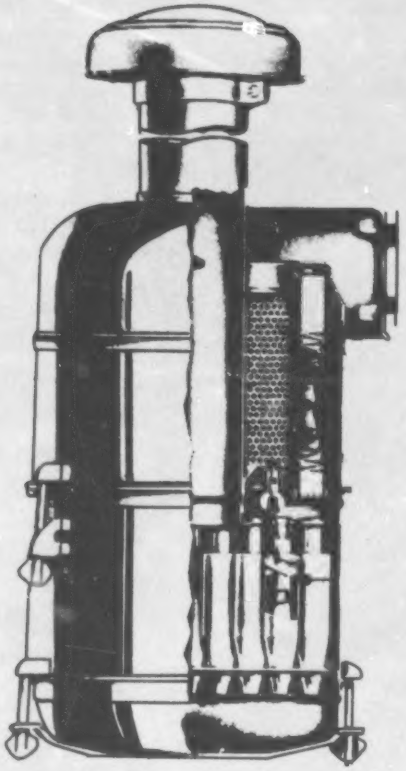
HEO I - 45-D

Types of Air Cleaners

(Continued)

Viscous-Impingement Air Cleaner

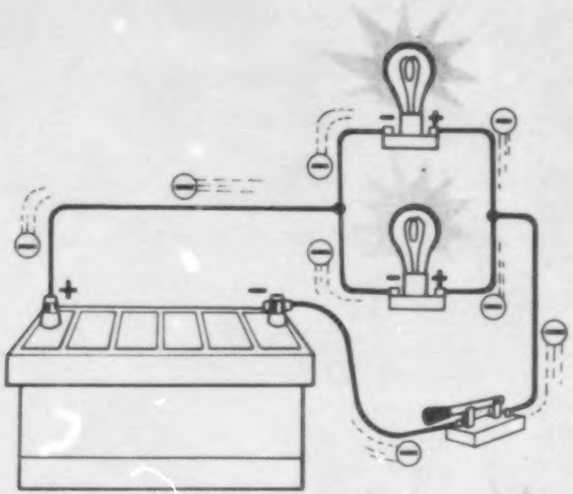




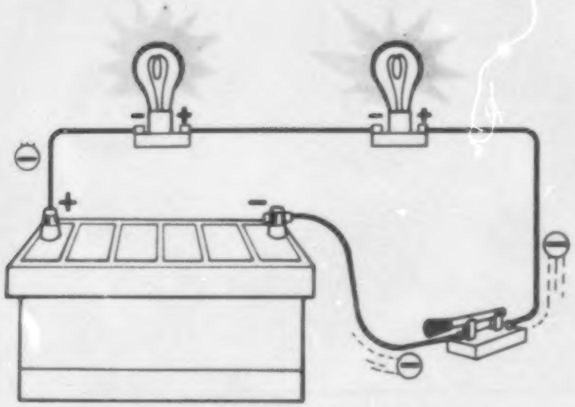
Dry Element Air Cleaner

Used with permission of the Caterpillar Tractor Co.

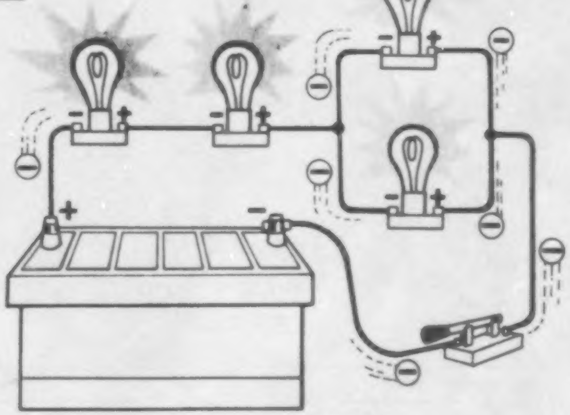
Types of Electrical Circuits



Parallel Circuit

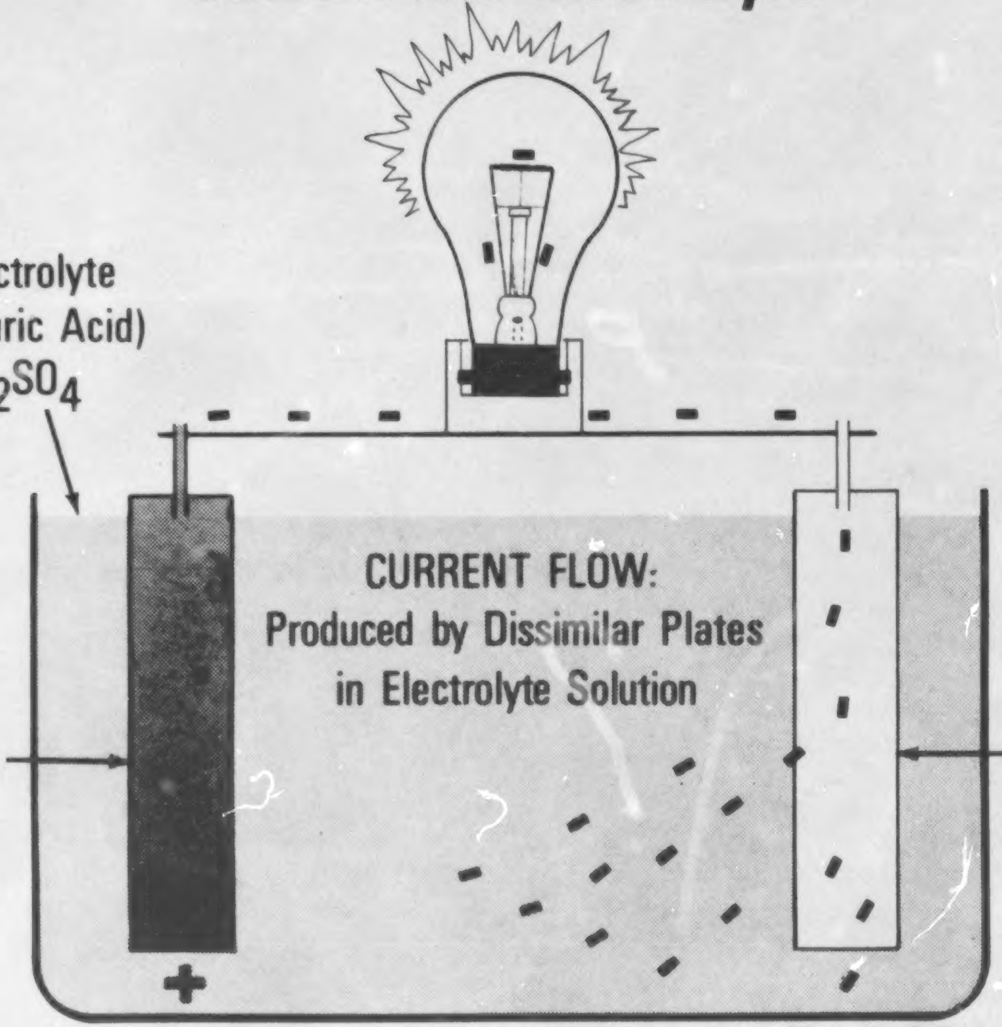


Series Circuit



Series-Parallel Circuit

Current and Electrolyte



Electrolyte
(Sulfuric Acid)
H_2SO_4

CURRENT FLOW:
Produced by Dissimilar Plates
in Electrolyte Solution

Positive Plate
Lead Peroxide

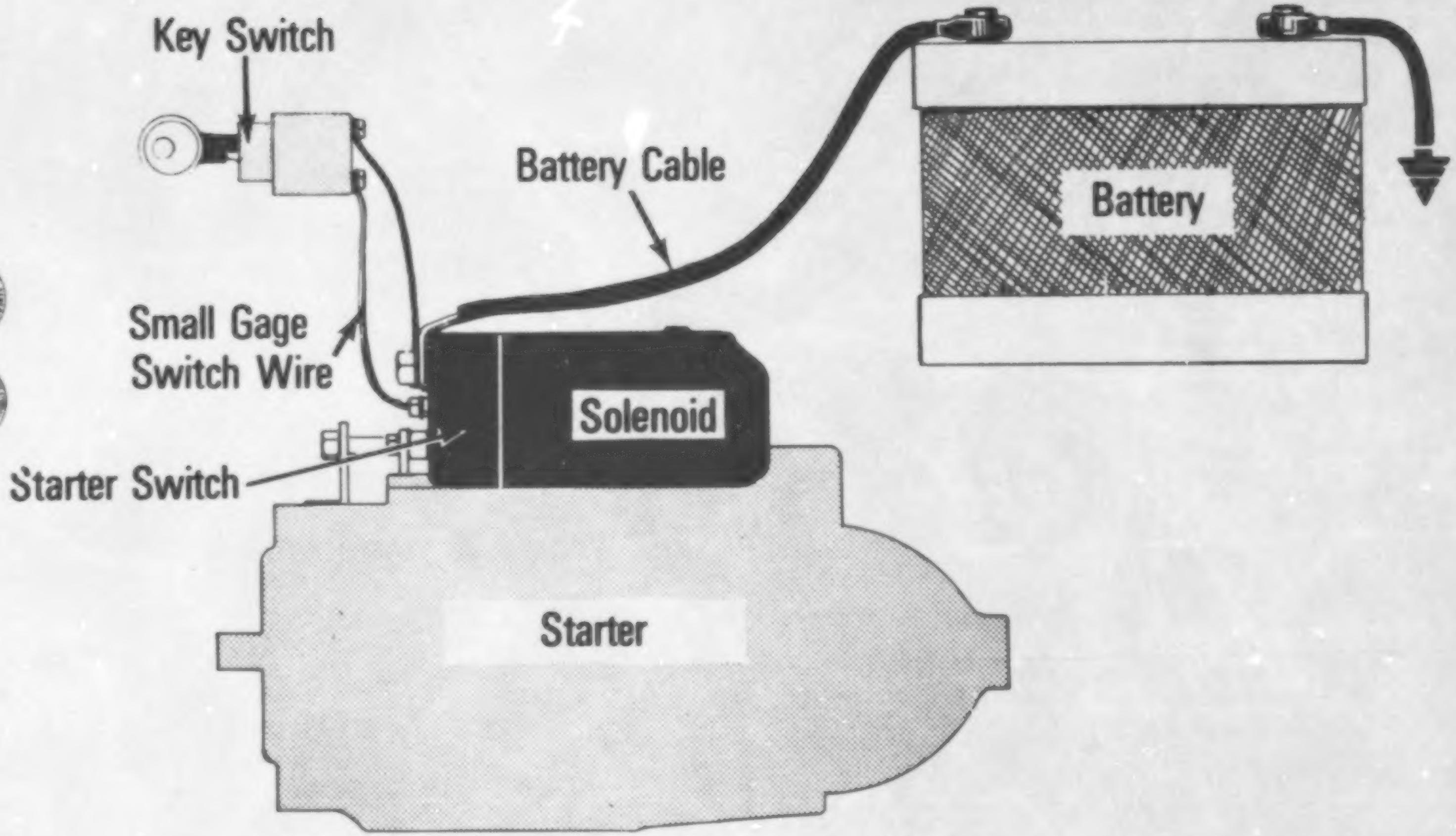
Negative Plate
Sponge Lead

How a Battery Converts Chemical Energy into Electrical Energy

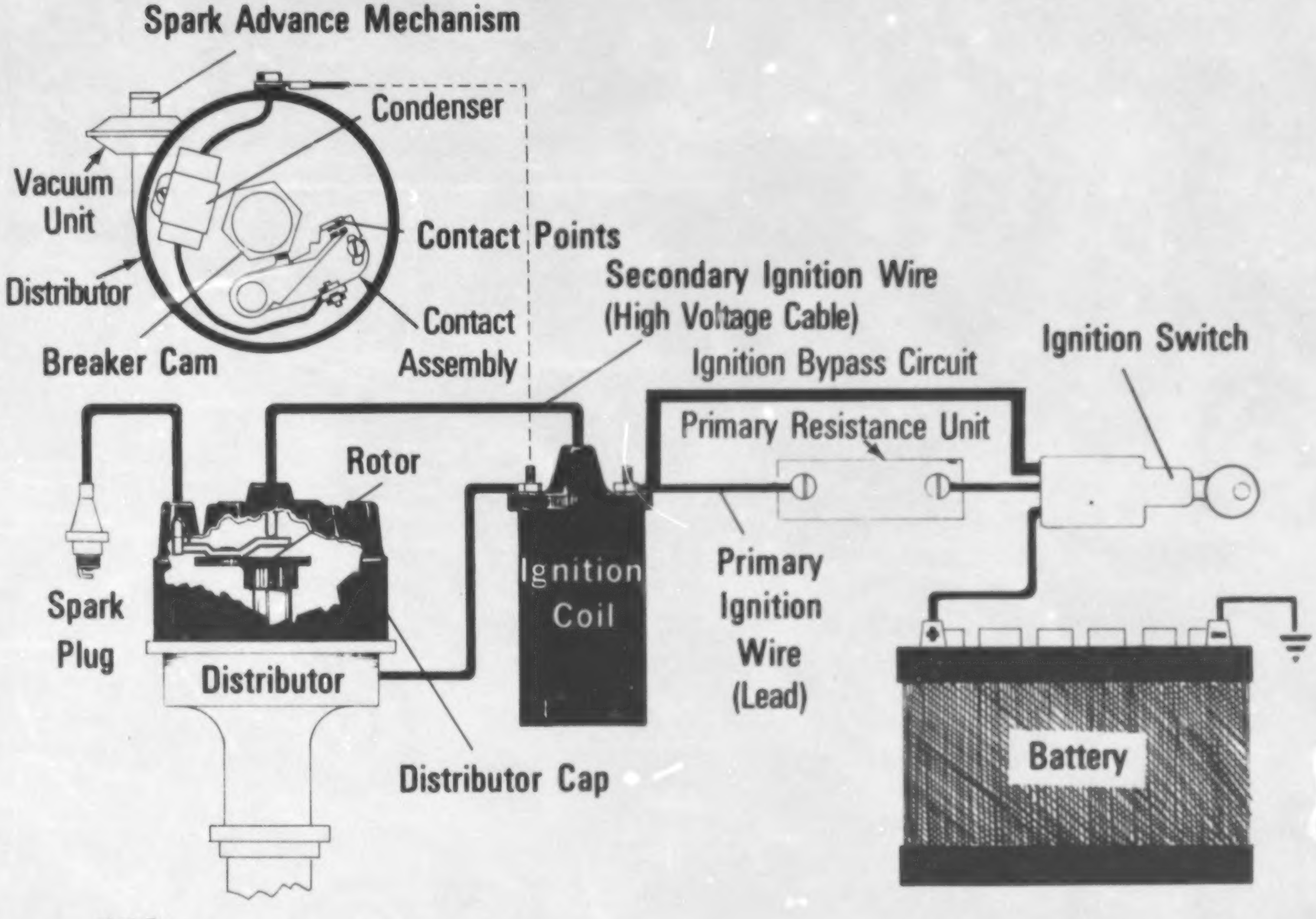
TM 12

HEO I-51-D

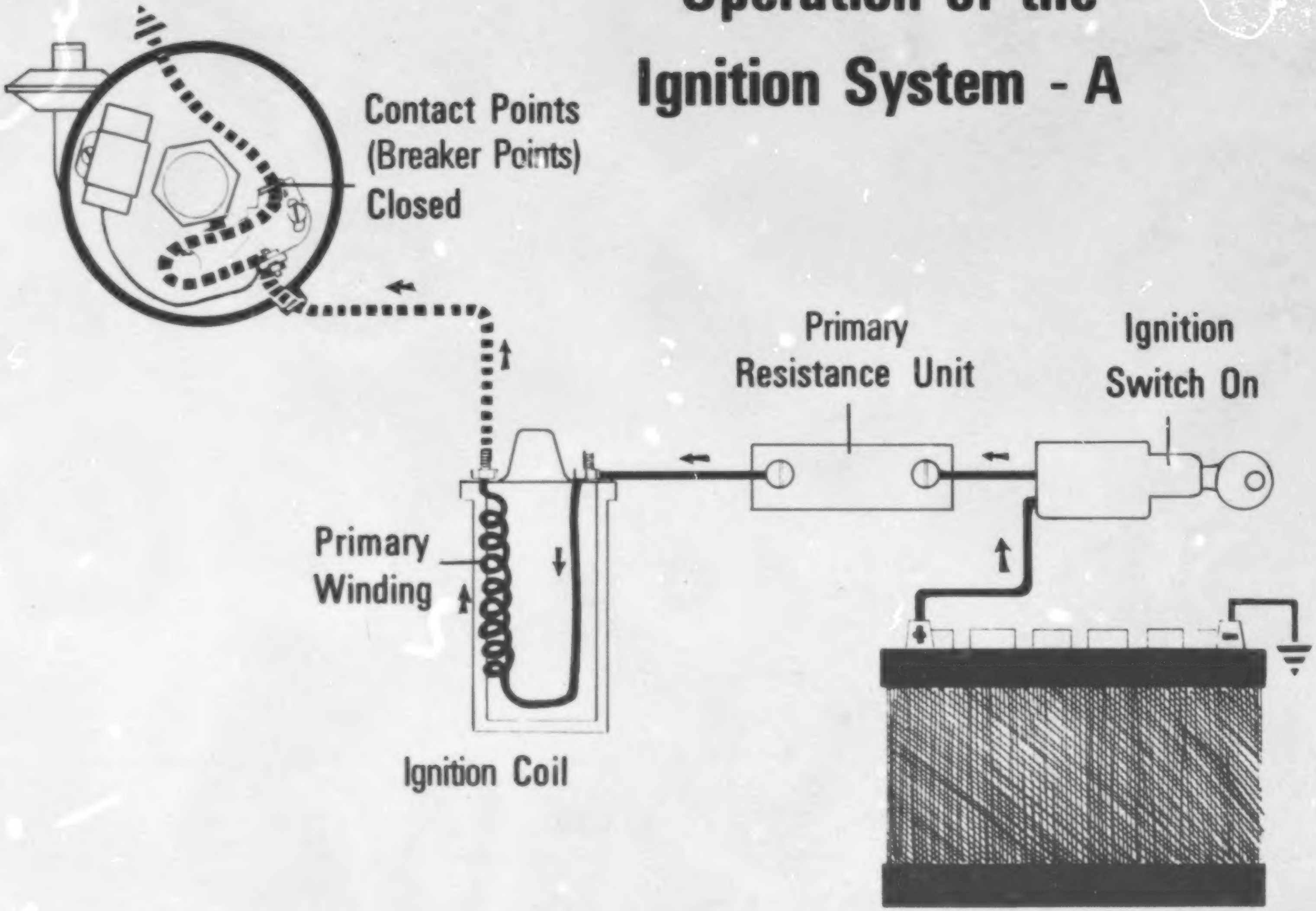
Components Of The Starting System


Key Switch
Battery Cable
Battery
Small Gage Switch Wire
Solenoid
Starter Switch
Starter

Major Components of the Ignition System


Spark Advance Mechanism
Condenser
Vacuum Unit
Contact Points
Distributor
Secondary Ignition Wire (High Voltage Cable)
Contact Assembly
Ignition Switch
Breaker Cam
Ignition Bypass Circuit
Primary Resistance Unit
Rotor
Ignition Coil
Primary Ignition Wire (Lead)
Spark Plug
Distributor
Battery
Distributor Cap

Operation of the Ignition System - A



Contact Points
(Breaker Points)
Closed

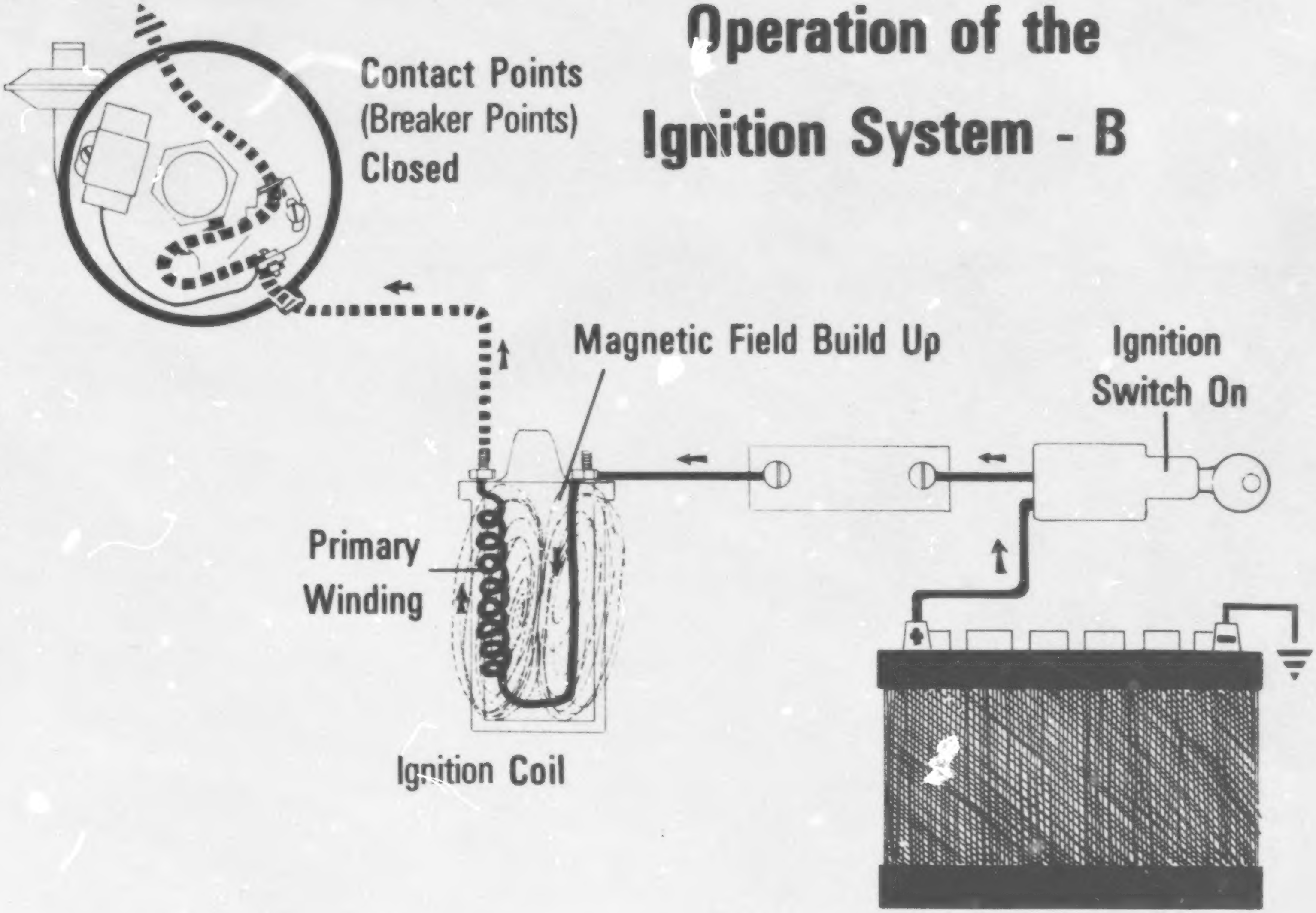
Primary
Resistance Unit

Ignition
Switch On

Primary
Winding

Ignition Coil

Operation of the Ignition System - B



Contact Points
(Breaker Points)
Closed

Magnetic Field Build Up

Ignition
Switch On

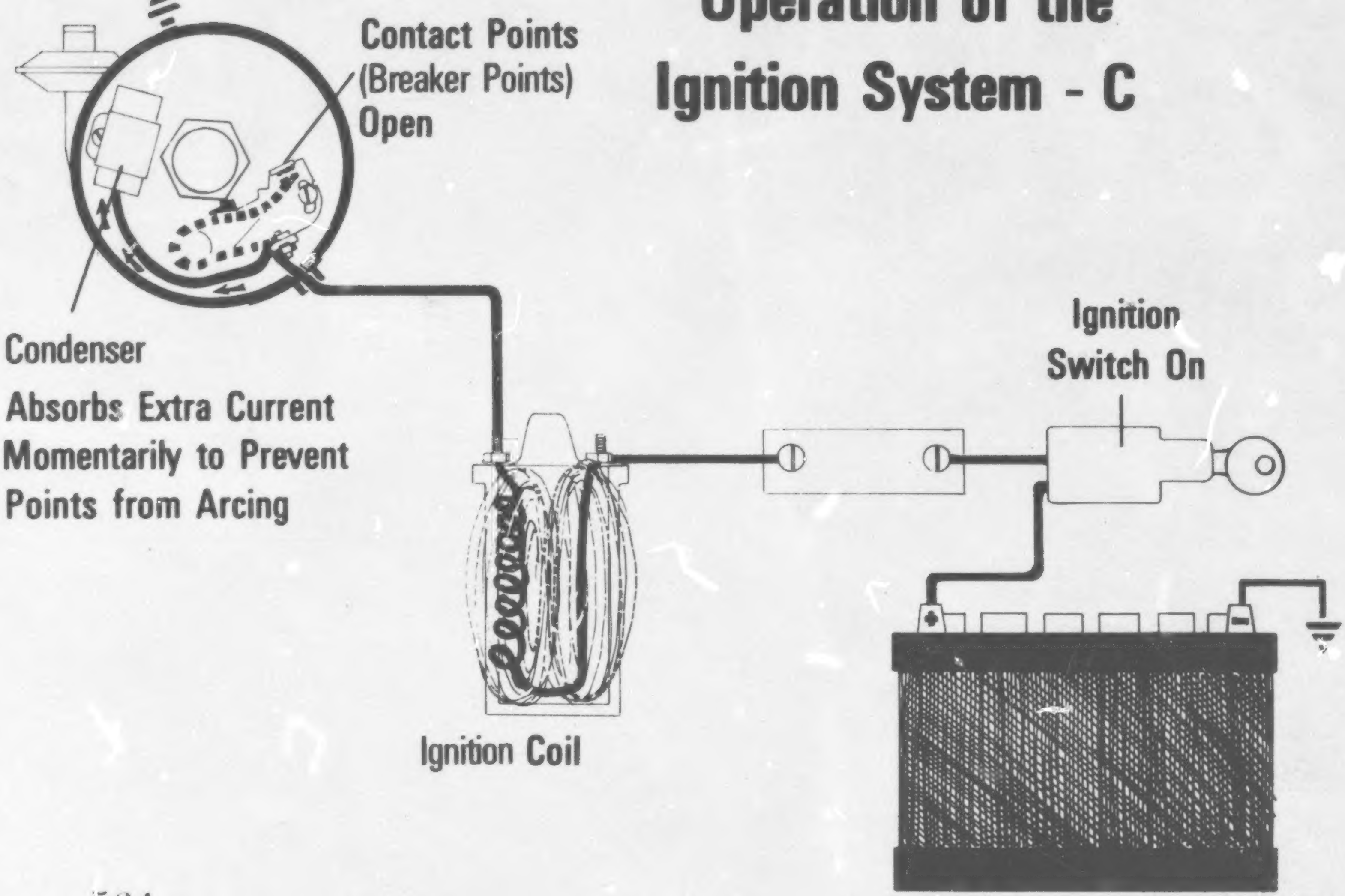
Primary
Winding

Ignition Coil

TM 16

HEO I - 59-D

Operation of the Ignition System - C



Contact Points
(Breaker Points)
Open

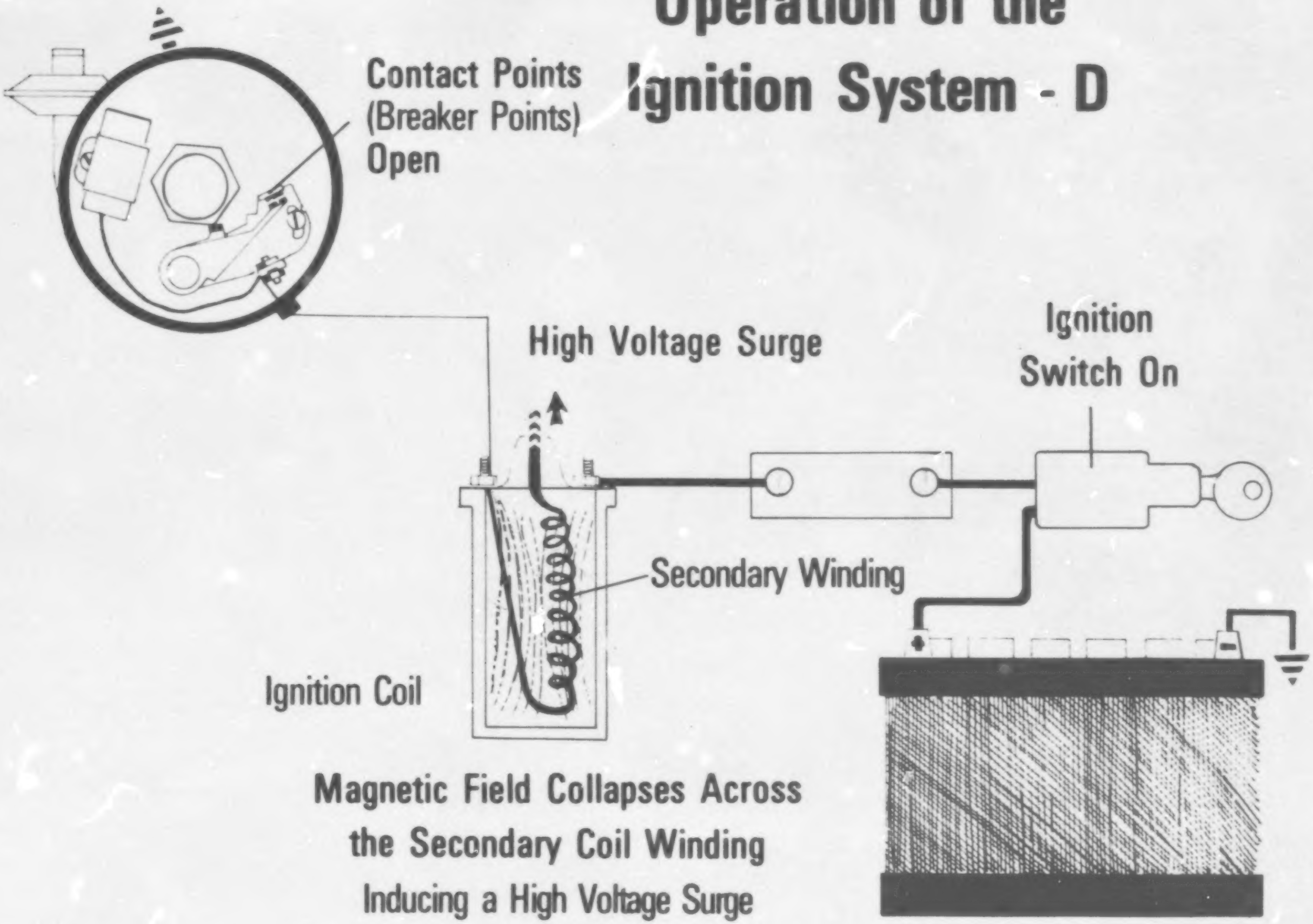
Condenser

Absorbs Extra Current
Momentarily to Prevent
Points from Arcing

Ignition
Switch On

Ignition Coil

Operation of the Ignition System - D



Contact Points (Breaker Points) Open

High Voltage Surge

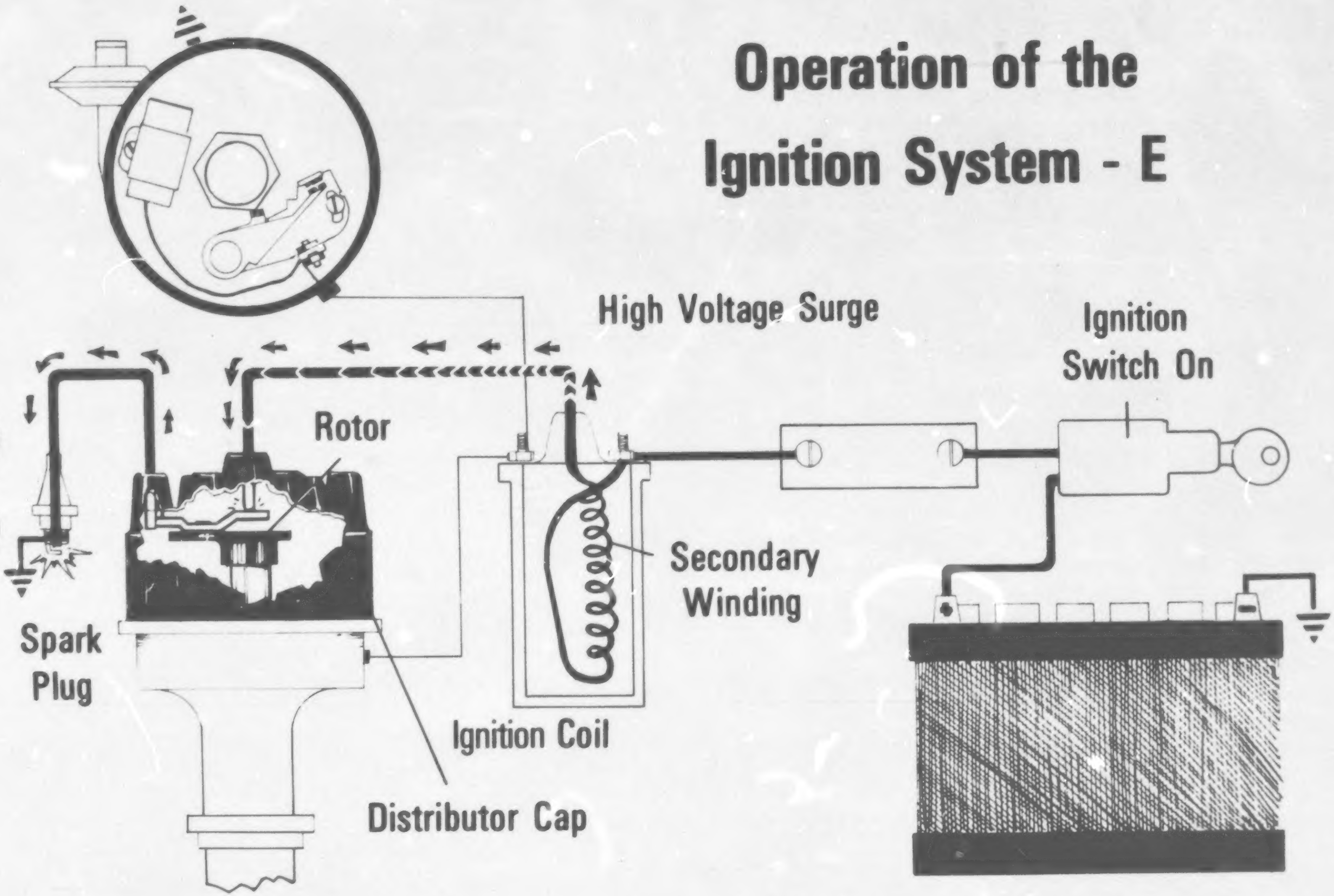
Ignition Switch On

Secondary Winding

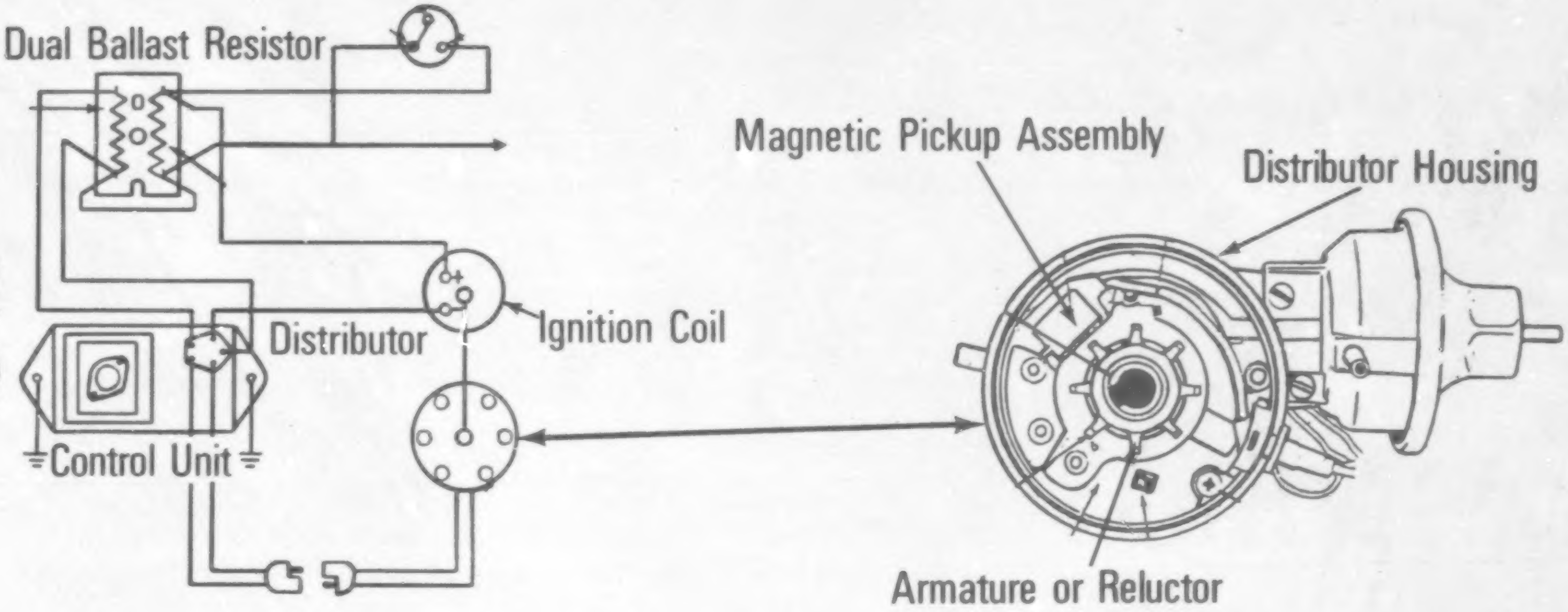
Ignition Coil

Magnetic Field Collapses Across the Secondary Coil Winding Inducing a High Voltage Surge

Operation of the Ignition System - E


High Voltage Surge
Ignition Switch On
Rotor
Spark Plug
Secondary Winding
Ignition Coil
Distributor Cap

Major Components of the Electronic Ignition System


Dual Ballast Resistor
Magnetic Pickup Assembly
Distributor Housing
Distributor
Ignition Coil
Control Unit
Armature or Reluctor

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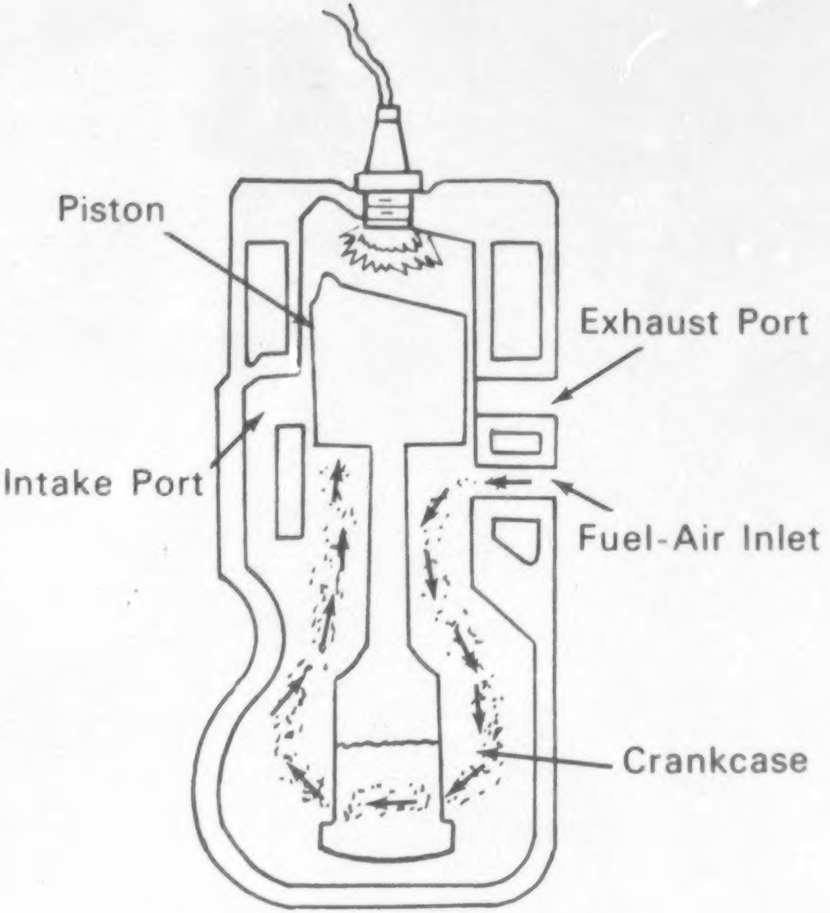
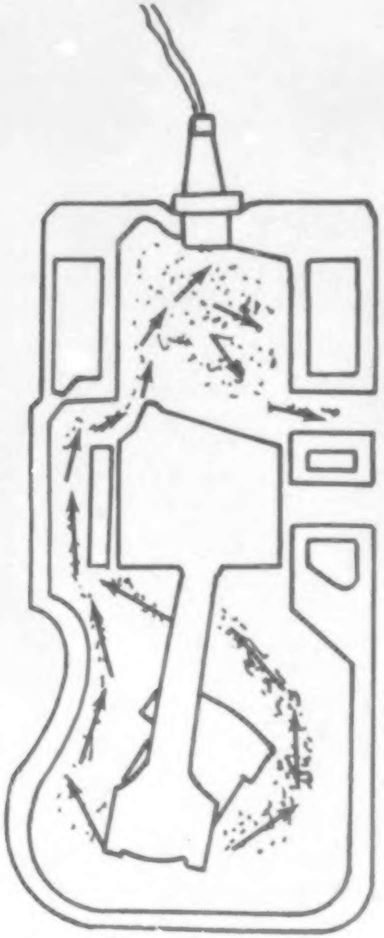
Crankcase Scavenging Engine


Piston
Exhaust Port
Intake Port
Fuel-Air Inlet
Crankcase

Compression/Power Stroke



Intake/Exhaust Stroke

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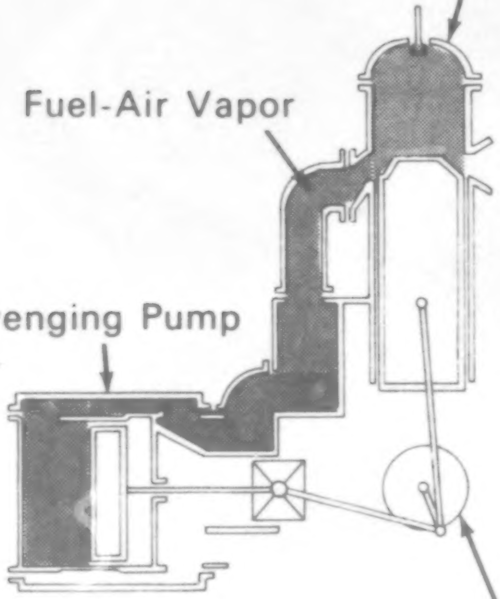
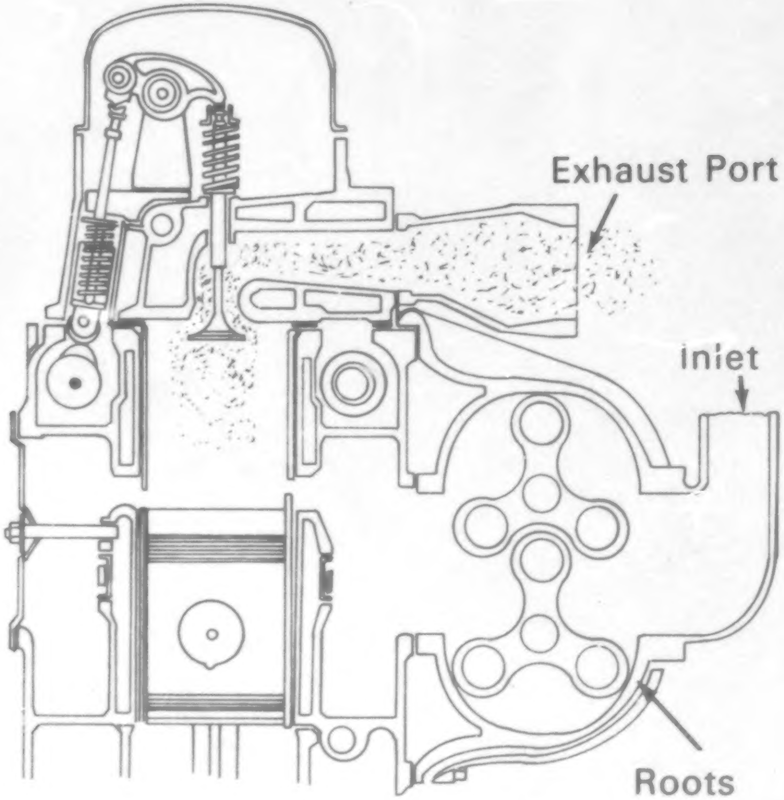
TM 21

HEO I-69-D

Scavenging Pump And Blower


Power Cylinder
Fuel-Air Vapor
Scavenging Pump
Crankshaft Drives Pump

POWER PISTON


Exhaust Port
Inlet
Roots
Supercharger Or Blower

POSITIVE DISPLACEMENT

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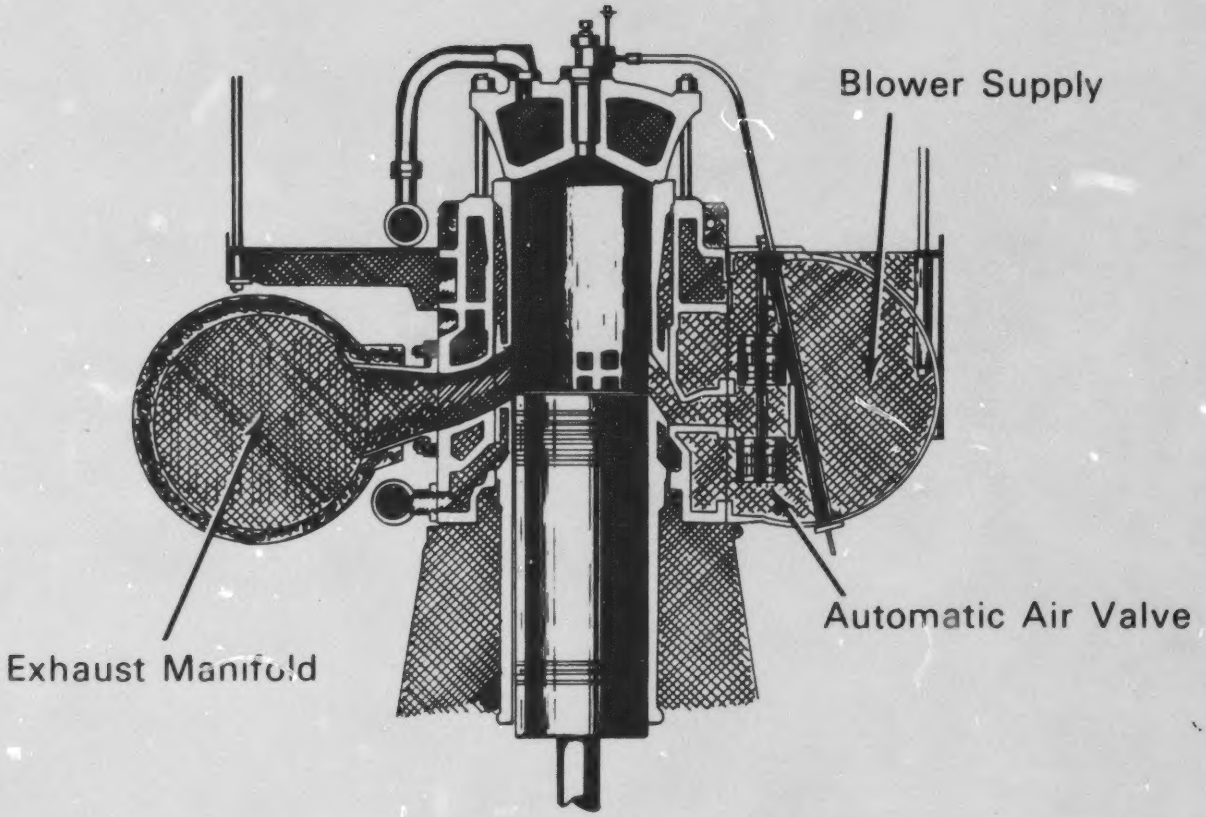
TM 22

HEO I-71-D

Port-Scavenged Engine


Blower Supply
Automatic Air Valve
Exhaust Manifold

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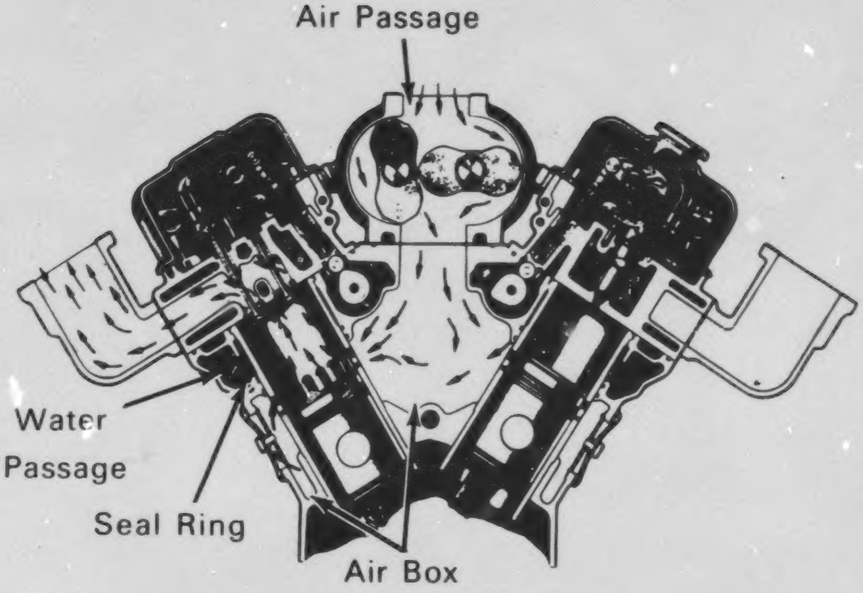
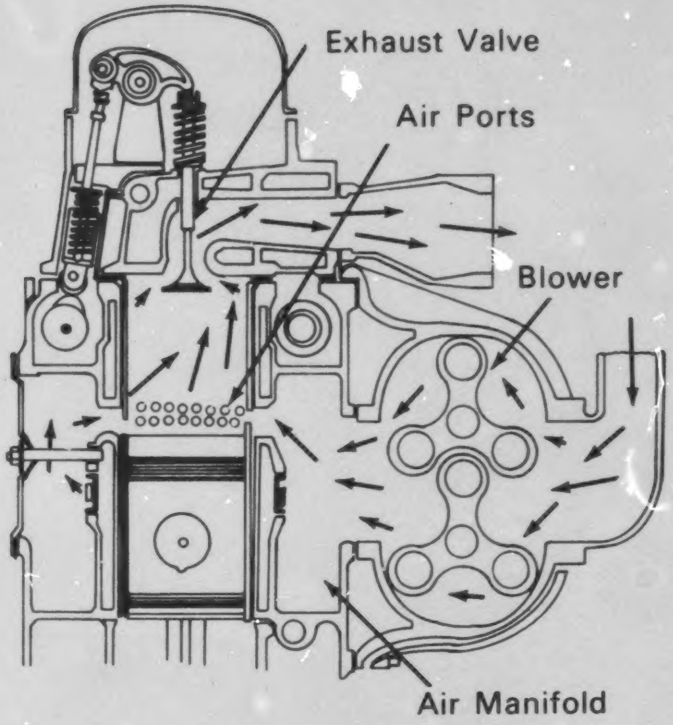
Valve-Scavenged Engine


Air Passage
Water Passage
Seal Ring
Air Box

V-TYPE


Exhaust Valve
Air Ports
Blower
Air Manifold

IN-LINE-TYPE

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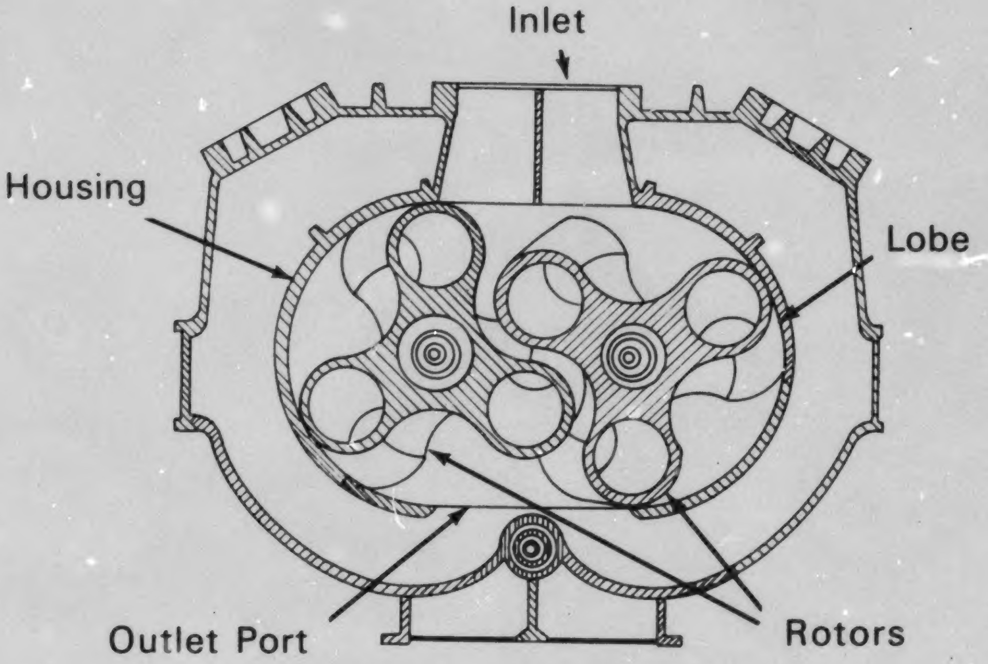
Positive Displacement Supercharger


Inlet
Housing
Lobe
Outlet Port
Rotors

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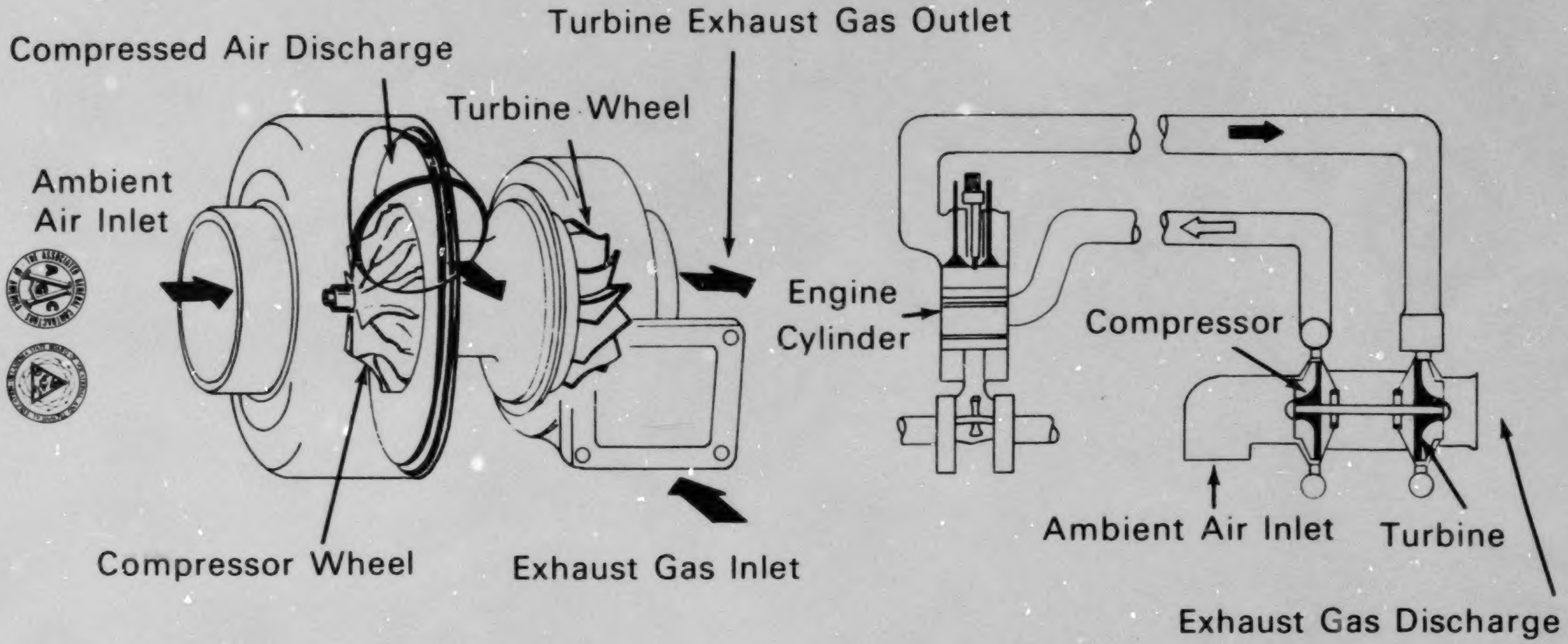
TM 25

HEO I-77-D

Centrifugal-Type Supercharger


Compressed Air Discharge
Turbine Exhaust Gas Outlet
Turbine Wheel
Ambient Air Inlet
Engine Cylinder
Compressor
Ambient Air Inlet
Turbine
Compressor Wheel
Exhaust Gas Inlet
Exhaust Gas Discharge

➡ Engine Exhaust Gas Flow

⇨ Compressed Air Flow

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BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #1--TEST THERMOSTAT ACTION

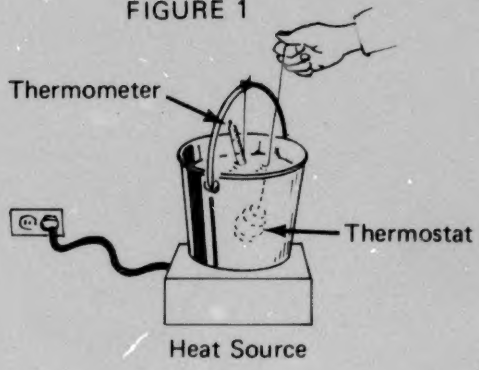
I. Tools and materials

- A. Heat source
- B. Container of water
- C. Thermometer
- D. Thermostat
- E. Safety glasses

II. Procedure

- A. Suspend the thermostat and thermometer in container of water (Figure 1)

FIGURE 1



- B. Compare the temperature rating stamped on the frame of thermostat to the thermometer
- C. Thermostat should start to open at the temperature stamped on the frame and be fully open at 22°F above the specified temperature
- D. Remove thermostat and observe its closing action
- E. If thermostat is defective, discard

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #2--TEST FOR EXHAUST GAS LEAKAGE AND AIR IN COOLING SYSTEM

I. Tools and materials

   A. Live engine

   B. Rubber tube

   C. Bottle of water

   D. Safety glasses

II. Procedure

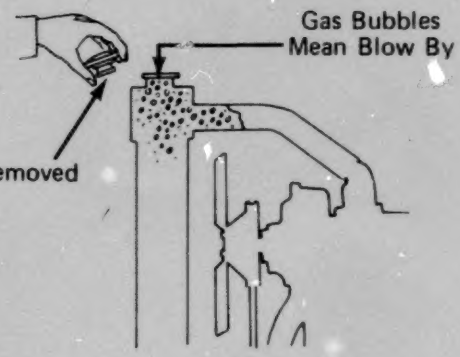
   A. Test for exhaust gas leakage (blow-by)

      1. Warm up the engine and keep it under load

      2. Remove the radiator cap and look for excessive bubbles in the coolant (Figure 1)

      (NOTE: Never remove radiator cap quickly when engine is hot. Loosen cap slowly to first stop and leave in this position until all pressure is released. Cap can then be removed safely.)

FIGURE 1



JOB SHEET #2

3. Look for a sign of blow-by such as bubbling or an oil film on the coolant

   (NOTE: A cracked head or a loose cylinder head joint allows hot exhaust gas to be blown into the cooling system under combustion pressure, even though the joint may be tight enough to keep liquid from leaking into the cylinder. The cylinder head gasket itself may be burned and corroded by escaping exhaust gases. Exhaust gases dissolved in coolant destroy the inhibitors and form acids which cause corrosion, rust, and clogging.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #3--TEST ANTIFREEZE SOLUTION

I. Equipment--Antifreeze hydrometer tester

II. Procedure

A. Start engine and allow time for coolant to warm up to operating temperature

B. Remove radiator cap

(CAUTION: Never remove the radiator cap quickly when the engine is hot. Loosen cap slowly to first stop and leave in this position until all pressure is released. Cap can then be removed safely.)

C. Draw antifreeze into tester and empty several times to equalize the temperature of all parts

D. Draw antifreeze into tester

E. Read the first number or letter on the float above the liquid surface

F. Note temperature of antifreeze

G. Measure antifreeze content of the water by comparing the readings with the chart on the tester

(NOTE: The antifreeze content should be such that the cooling system would be protected to 10°F [5°C] lower than the coldest temperature expected.)

H. Add antifreeze if necessary

(NOTE: If antifreeze is added, it will be necessary to drain old antifreeze from the system to make room for the new that is added. Be sure to allow room for expansion.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #4--SERVICE AN AIR CLEANER

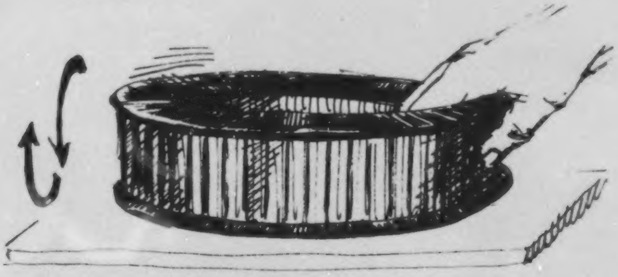
I. Tools and equipment

- A. Compressed air
- B. Container of solvent
- C. Cleaning brush
- D. Shop towels
- E. Screwdriver

II. Procedure

- A. Remove the air cleaner fasteners
- B. Remove the air cleaner and air cleaner cover
- C. Determine the type of air cleaner element
  - 1. Paper air cleaner element
    - a. Should be replaced at specified intervals
    - b. May be cleaned between intervals of replacement by tapping lightly on a flat surface, or by directing a controlled stream of compressed air through the element opposite normal air flow (Figures 1 and 2)

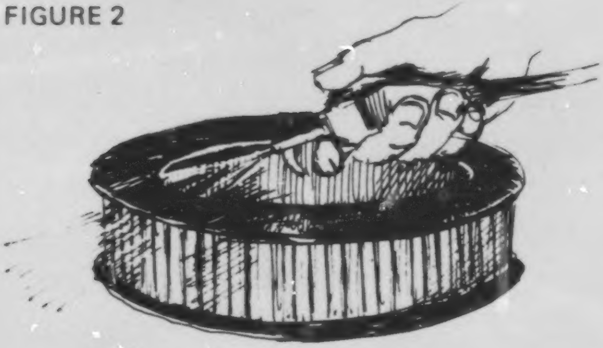
FIGURE 1



Tap lightly on a flat surface

JOB SHEET #4

FIGURE 2



Direct a controlled stream of air through filter

c. Check the element against the light before reinstalling to make sure that there are no holes or ruptures present

d. Check bottom and top gasket surfaces of the paper element for damage

e. Install right side up where indicated

2. Polyurethane element

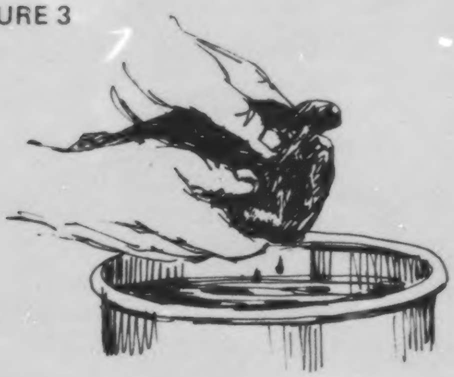
a. Remove the polyurethane element from the support screen

b. Wash it thoroughly in clean solvent

c. Squeeze out the solvent (Figure 3)

(NOTE: Do not wring because the element might tear.)

FIGURE 3



JOB SHEET #4

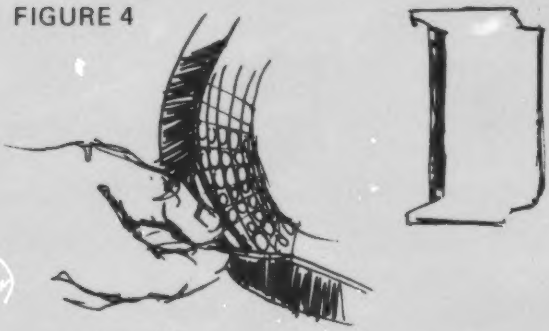
d. Re-oil the filter element with clean engine oil

e. Squeeze excess oil from filter element

f. Replace element on support screen (Figure 4)

(NOTE: Make sure the element is placed on the support screen to form a sound seal for both top and bottom contact edges.)

FIGURE 4

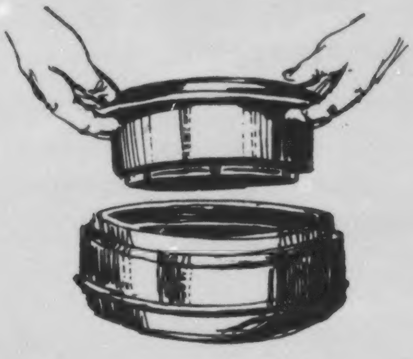


3. Oil bath air cleaner

a. Remove wing nut

b. Lift out gauze air strainer (Figure 5)

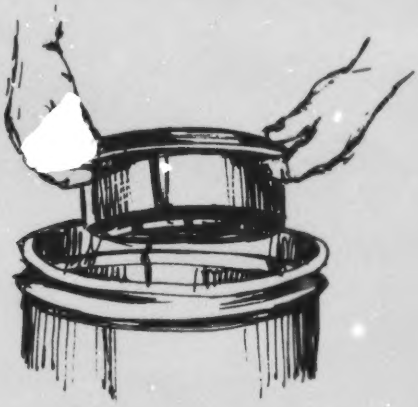
FIGURE 5



JOB SHEET #4

c. Rinse air strainer in clean solvent (Figure 6)

FIGURE 6



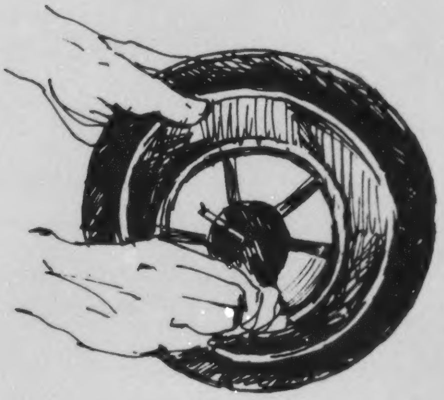
d. Shake excessive solvent from the air strainer

e. Saturate the air strainer gauze with light oil and allow excess to drip off

f. Pour out oil in lower body and discard

g. Wash dirt and grit out of lower body with clean solvent (Figure 7)

FIGURE 7

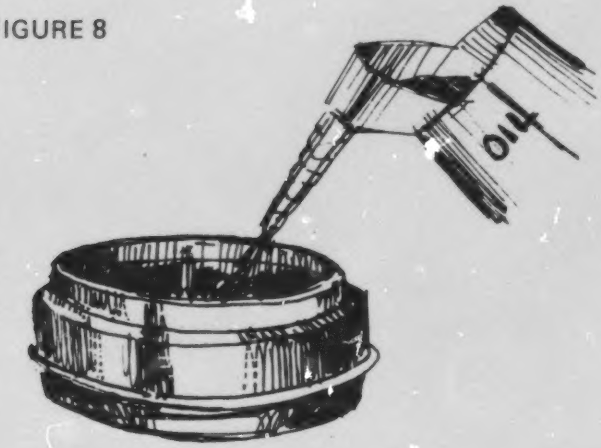


JOB SHEET #4

h. Fill lower body to correct level with fresh engine oil of sufficient SAE specification (Figure 8)

(NOTE: Do not overfill.)

FIGURE 8



i. Place units together and install wing nut

(NOTE: Make sure gasket is in place between the air strainer and lower body.)

j. Tighten wing nut securely

D. Clean the filter body and cover before replacing

E. Make certain that the gasket between the air cleaner and carburetor is in good condition and is in place; replace if necessary

F. Replace the air cleaner body

(NOTE: Make sure the air cleaner faces in the correct direction. If a locating lug is present, make sure it engages properly.)

G. Tighten the air cleaner wing nut

(NOTE: Do not overtighten. Overtightening can cause improper operation of the choke.)

H. Install other hoses or vacuum lines as required

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #5--CLEAN AND SERVICE A BATTERY

I. Tools and equipment

- A. Full face shield
- B. Rubber gloves
- C. Rubber apron
- D. Bristle brush
- E. Wire brush
- F. Screwdriver
- G. Battery clamp puller
- H. Combination end wrenches, 7/16" - 9/16"
- I. Baking soda and water solution (two tablespoons of baking soda to one pint of water)
- J. Battery anti-corrosion paste
- K. Shop towels

II. Procedure

- A. Disconnect battery cables from the battery posts

  (NOTE: Always disconnect the grounded battery cable first to avoid short circuits. Use care to avoid twisting the battery cable post.)

  1. Pry clamp open (Figures 1 and 2)

FIGURE 1

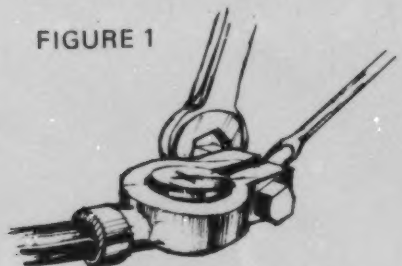
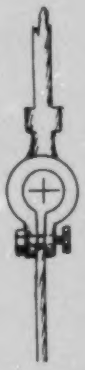


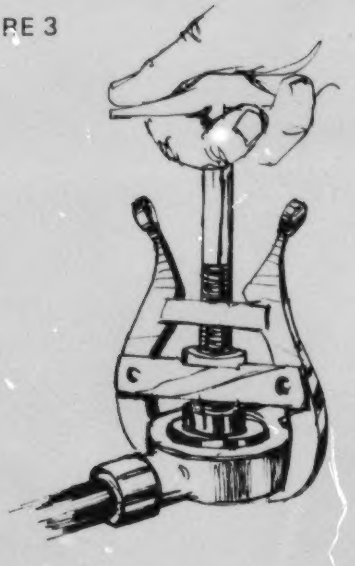
FIGURE 2



JOB SHEET #5

2. Pull cable off (Figure 3)

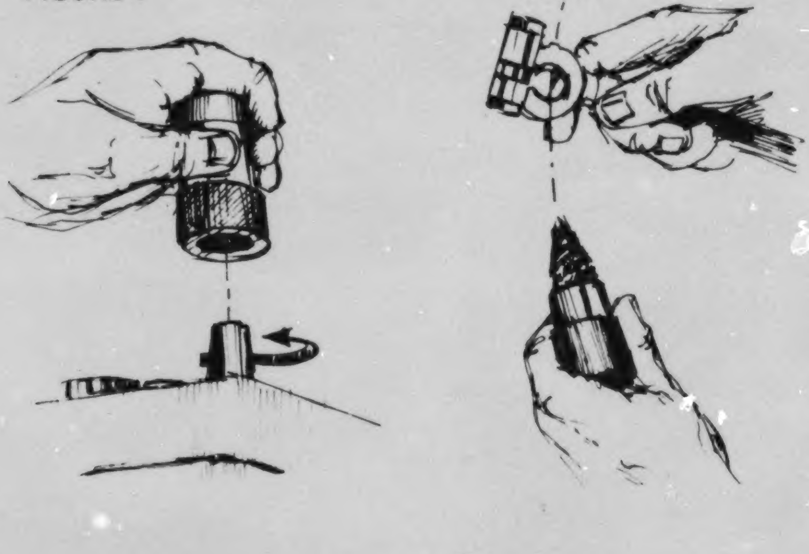
FIGURE 3



B. Clean battery cable clamps and battery post (Figure 4)

(NOTE: Battery posts and inside of battery cable clamps must be clean and bright.)

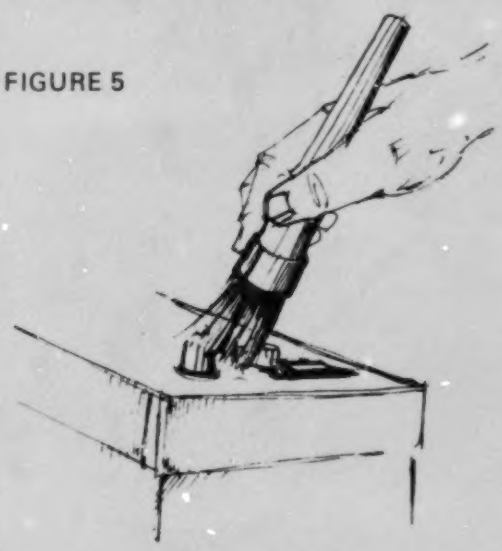
FIGURE 4



JOB SHEET #5

C. Remove loose dirt and corrosion particles from top of battery (Figure 5)

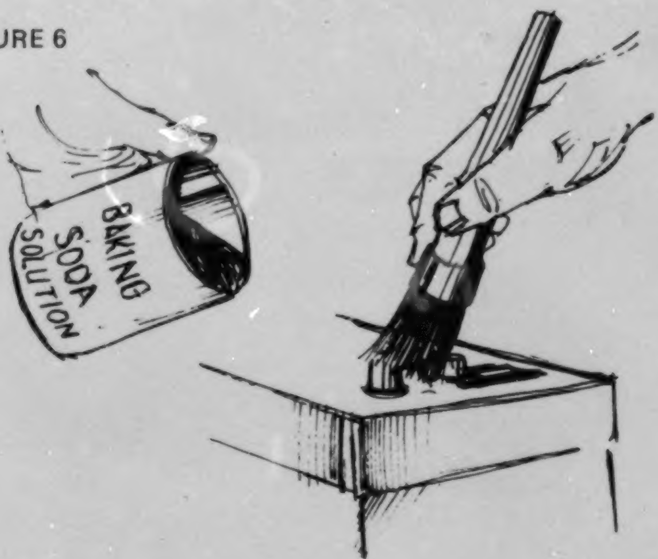
FIGURE 5



D. Brush soda-water solution on battery, battery post, clamps, and battery hold-down (Figure 6)

(NOTE: Keep water and soda from entering the battery through the vent holes in the vent caps.)

FIGURE 6



JOB SHEET #5

E. Wash away residue with clean water (Figure 7)

(NOTE: Remove all residue that may have lodged around battery, frame, or parts of the vehicle.)

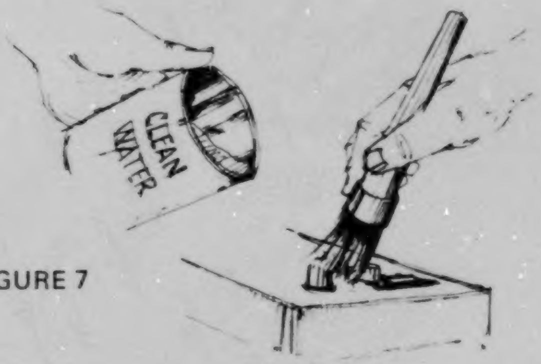
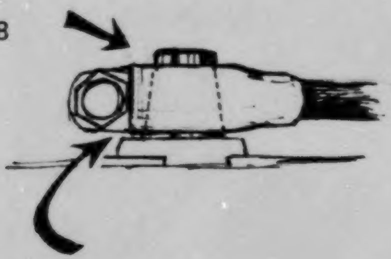


FIGURE 7

F. Dry the battery and battery cables with a clean cloth

G. Reconnect battery cables to the battery posts (Figure 8)

(CAUTION: Always reconnect the power cable first and the ground cable last.)



Battery Post Slightly Above Clamp

FIGURE 8

H. Spread a coating of battery anti-corrosion paste over the cable clamps and terminals

I. Remove vent caps

J. Check electroyte level in all cells

K. Add water if necessary to bring electrolyte up to proper level

(NOTE: Do not overfill.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #6--REMOVE AND REPLACE A BATTERY

I. Tools and equipment

- A. Full face shield
- B. Protective clothing
- C. Wire brush
- D. Screwdriver
- E. Battery clamp puller
- F. Combination end wrenches, 7/16" - 9/16"
- G. Battery cable spreader
- H. Battery post and cable cleaner
- I. Battery lift strap

II. Procedure

(NOTE: Observe the location of the positive post so that the battery can be installed in the same way.)

A. Disconnect the battery cables from the battery posts

(NOTE: Always disconnect the grounded battery cable first to avoid short circuits. Use care to avoid twisting the battery cable post.)

1. Pry clamp open (Figures 1 and 2)

FIGURE 1

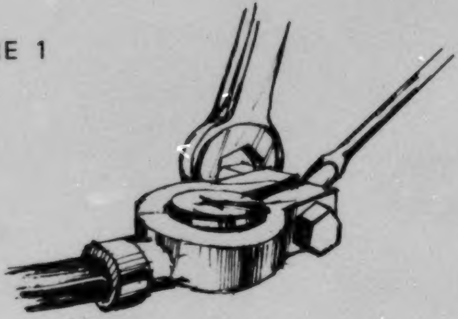
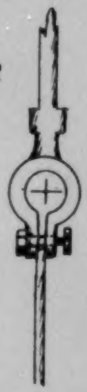


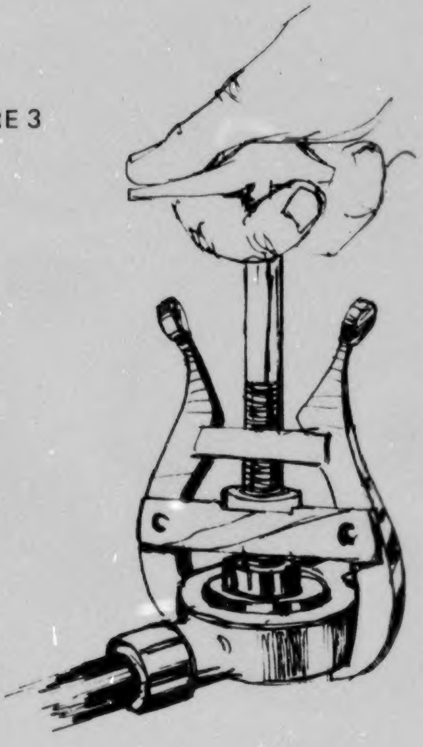
FIGURE 2



JOB SHEET #6

2. Pull cable off (Figure 3)

FIGURE 3



B. Remove the battery hold-down

C. Remove the battery from the carrier

(NOTE: Use a suitable battery lift strap to lift the battery.)

D. Inspect the battery carrier for dirt or corrosion

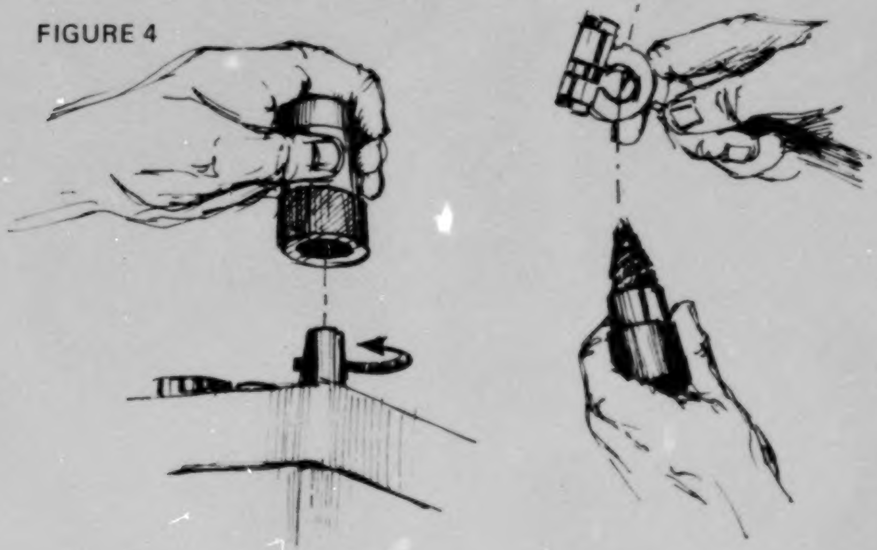
(NOTE: Clean with baking soda and water solution as required.)

E. Check battery cables for worn or frayed insulation

JOB SHEET #6

F. Clean the inside of battery cables until bright (Figure 4)

FIGURE 4



G. Set the battery into place using a lift strap

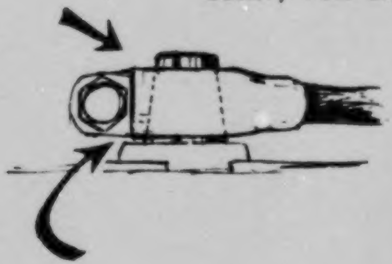
(NOTE: Position the battery to allow for correct battery cable attachment.)

H. Install the battery hold-down clamp or strap and tighten securely

I. Reconnect battery cables to the battery posts (Figure 5)

(NOTE: Always reconnect the power cable first and the ground cable last.)

FIGURE 5



Battery Post Slightly Above Clamp

J. Tighten the battery cable clamps securely

(NOTE: Use care to avoid twisting the battery cable post.)

K. Spread a coating of battery anti-corrosion paste over the cable clamps and terminals

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #7--MEASURE BATTERY ELECTROLYTE WITH A HYDROMETER

I. Tools and equipment

- A. Hydrometer
- B. Shop towels
- C. Water container

II. Procedure

A. Remove vent caps from battery

B. Insert the hydrometer into the first cell

C. Squeeze the rubber bulb to draw electrolyte into the hydrometer to suspend the float

(NOTE: If the electrolyte level is too low, add water until electrolyte level is correct; charge for one hour, and recheck.)

D. Take reading at eye level (Figure 1)

(NOTE: Make sure the float is not bumping the top of hydrometer tube or sticking to the side of the tube. Write down reading for each cell.)

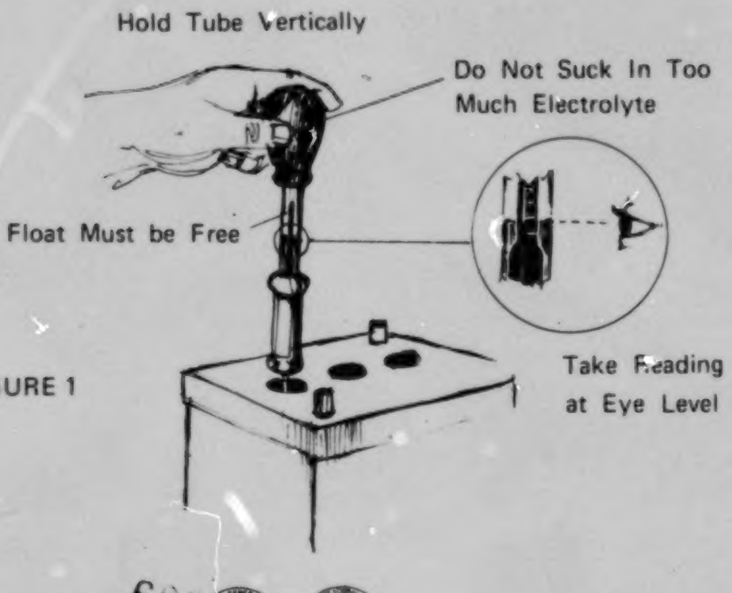

Hold Tube Vertically
Do Not Suck In Too Much Electrolyte
Float Must be Free
Take Reading at Eye Level

FIGURE 1

JOB SHEET #7

E. Squeeze bulb to return electrolyte to cell

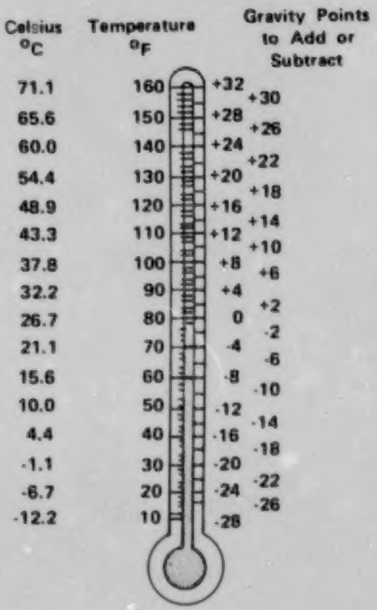
F. Repeat for other cells

G. Adjust the readings for temperature (Figure 2)

1. Add four gravity points (0.004) to the reading for each 10°F (5.5°C) above 80°F (26.7°C)

2. Subtract four gravity points (0.004) for each 10°F (5.5°C) below 80°F (26.7°C)

FIGURE 2



Temperature Adjustment Chart

(NOTE: Specific gravity should read from 1.215 to 1.270, corrected for 80°F [26.7°C] electrolyte temperature. The variation in readings between cells should be no more than 0.050. If the readings are not within this range, further testing will be required.)

H. Replace vent caps upon completion of test

I. Flush any spilled electrolyte with clean water

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #8--START AN ENGINE USING A NEGATIVE-GROUND BOOSTER BATTERY

I. Equipment

- A. Two engines
- B. Battery booster cables
- C. Shop cloths
- D. Face shield
- E. Rubber gloves
- F. Wire brush
- G. Negative-ground booster battery system

II. Procedure

(CAUTION: Use care in connecting a booster battery to avoid hurting yourself or damaging engine's electrical system.)

(NOTE: This procedure is Ford's recommendation for using a jumper between two vehicles [for a negative-ground battery].)

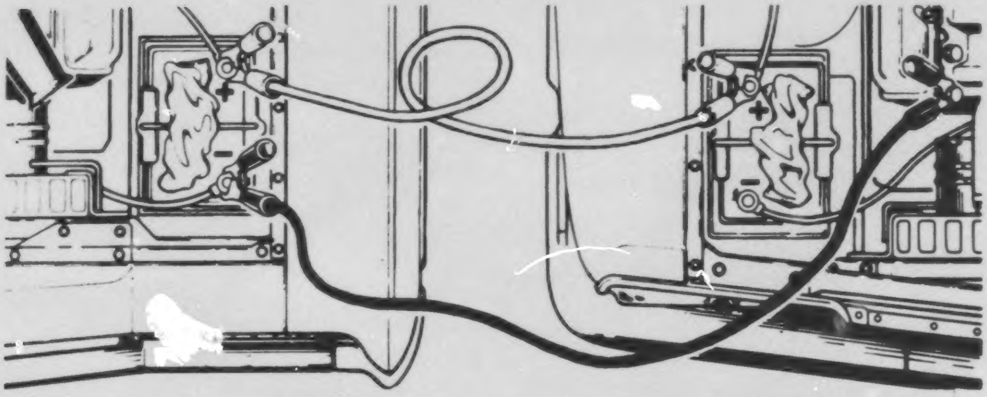
- A. Put on face shield and rubber gloves
- B. Use wire brush to clean connectors on battery
- C. Remove vent caps from both batteries
- D. Cover vent holes with shop cloths to prevent splashing of electrolyte
- E. Do not allow two machines to touch each other (if applicable)
- F. Be sure all electrical equipment is turned off on engine to be started
- G. Connect end of one cable to the positive (+) terminal of the booster battery
- H. Connect other end of cable to positive (+) terminal of dead battery
- I. Connect one end of second cable to negative (-) terminal of booster battery

JOB SHEET #8

J. Connect other end of second cable to engine block of engine you are trying to start (Figure 1)

(CAUTION: *Do not* connect second cable to negative [grounded] terminal of engine you are trying to start. This will prevent arcing around battery and a possible explosion.)

FIGURE 1



Charged Battery Dead Battery

From *Automotive Mechanics*, 8th ed., p. 275, Fig. 27.1, copyright 1980. Used with permission of the Gregg Division of McGraw-Hill Book Company.

K. Start engine which has the booster battery

(NOTE: After starting let engine run for a few minutes to help restore power to low battery.)

L. Start engine which has the low battery

M. Disconnect cable from engine block (providing engine started)

N. Disconnect other end of this cable

O. Disconnect second cable from engine with low battery

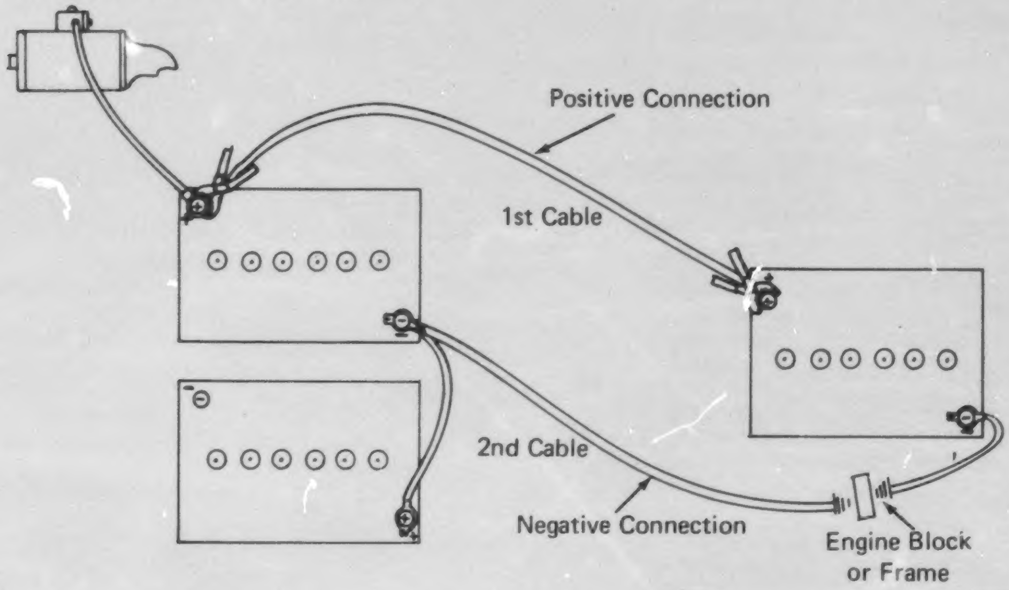
P. Disconnect other end of second cable from engine which has the booster battery

(CAUTION: Never operate starting motor for more than 30 seconds at a time. Pause for a few minutes to allow it to cool off, and then try again.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #9--USE A TWENTY-FOUR VOLT (24 V) BATTERY BOOSTER SYSTEM TO START A VEHICLE WITH A TWELVE VOLT (12 V) SYSTEM

(NOTE: This type of ground system [either positive (+) or negative (-)] can be boosted if both battery polarities are the same.)


Positive Connection
1st Cable
2nd Cable
Negative Connection
Engine Block or Frame

2 Battery 24 Volt Booster System

12V Discharged Battery

Caution: DO NOT use a single 24 volt battery to boost a 12 volt battery.)

I. Equipment

- A. Two vehicles
- B. Battery booster cables
- C. Face shields
- D. Two battery, 24 volt booster system
- E. Twelve-volt discharged battery
- F. Shop cloths
- G. Rubber gloves

JOB SHEET #9

II. Procedure

(CAUTION: Use care in connecting booster battery to avoid hurting yourself or damaging the electrical equipment.)

A. Position vehicles close enough to each other for booster cables to eaily reach batteries

(NOTE: Do not allow the two vehicles to touch each other. If the electrical systems in the two vehicles are not compatible, connecting them by allowing the vehicles to touch could cause serious damage.)

B. Make sure all electrical equipment except the ignition is turned off on the vehicle you are trying to start

C. Put on face shield and rubber gloves

D. Remove vent caps from both batteries

(NOTE: Cover the battery vent holes with shop cloths to prevent splashing of electrolyte.)

E. Connect end of one cable to the positive (+) terminal of the booster battery

F. Connect other end of cable to positive (+) terminal of discharged battery

(CAUTION: Never stand over battery when connecting cables.)

G. Connect one end of second cable to negative (-) terminal of booster battery

H. Connect other end of second cable to the engine block or frame of the vehicle you are trying to start

(CAUTION: Do not connect second cable to vehicle battery as this could cause a spark which could ignite any hydrogen in the battery and produce a serious explosion.)

I. Start vehicle which has the booster battery

(NOTE: Let engine idle a few minutes before trying to start other vehicle.)

J. Start vehicle with the discharged battery

(CAUTION: Never operate starting motor for more than thirty seconds at a time. Pause for a few minutes to allow it to cool off; then try again.)

JOB SHEET #9

K. Disconnect booster cables after disabled vehicle has started

L. Disconnect negative cable from engine block or frame first

M. Disconnect other end of negative cable from booster battery

N. Disconnect the other cable from positive terminals

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #10--REMOVE AND REPLACE CONTACT POINTS AND CONDENSER

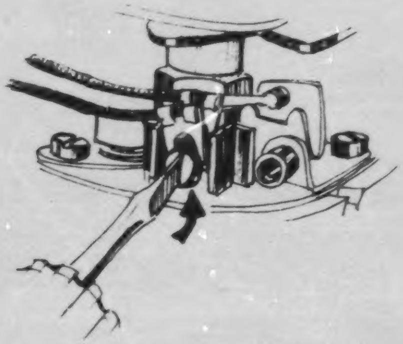
I. Tools and materials

- A. Basic hand tool set
- B. Ignition wrenches
- C. Feeler gauges, 0.010" - 0.025"
- D. Distributor cam lubricant
- E. Point alignment tools
- F. Timing light
- G. Shop towel
- H. Safety glasses

II. Procedure

- A. Remove distributor cap and place out of the way
- B. Remove rotor
- C. Determine condition of contact points and location of wires, screws, and eccentric as used
- D. Disconnect contact point primary lead wire and condenser wire by loosening screw (Figure 1)

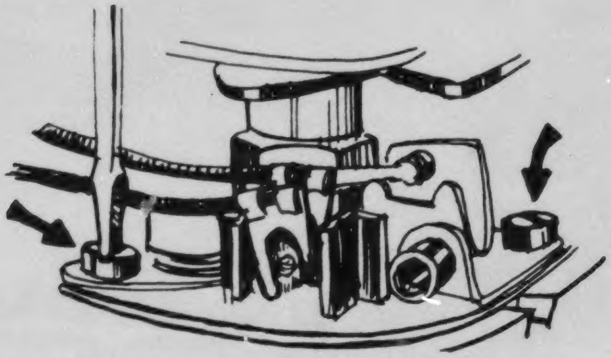
FIGURE 1



JOB SHEET #10

E. Loosen screws holding contact points in place (Figure 2)

FIGURE 2



F. Remove contact point set

G. Remove screw holding condenser in place

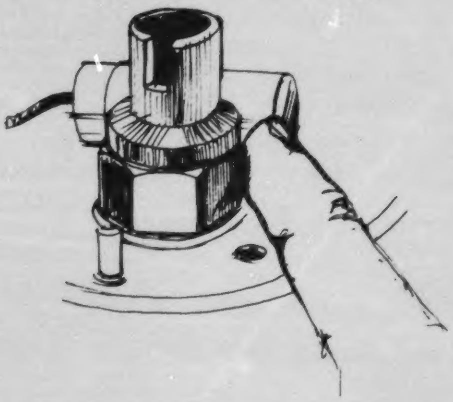
H. Remove condenser

I. Clean breaker plate and distributor cam

J. Lubricate the distributor cam with a light coat of cam lubricant (Figure 3)

(NOTE: On distributors with the centrifugal weights accessible, place a drop of light oil on each weight pivot post.)

FIGURE 3



LUBRICATE DISTRIBUTOR CAM

JOB SHEET #10

K. Place the contact points in distributor and install attaching screws

L. Replace condenser and attaching screws; tighten securely

M. Replace the primary lead and condenser wires

(NOTE: Position the wires in such a manner as to avoid binding or grounding.)

N. Tighten primary lead and condenser wires securely

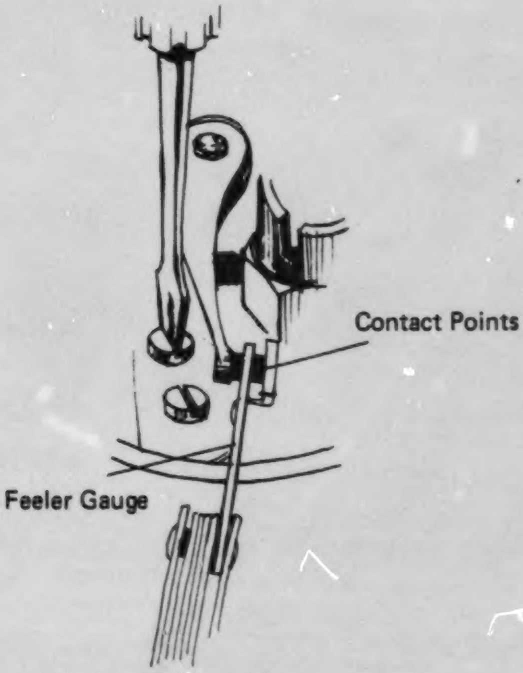
O. Check point alignment and adjust if required

P. Check contact point breaker spring tension

Q. Adjust contact point opening (Figure 4)

(NOTE: Crank the engine to position the rubbing block of the contact points on the peak of the cam lobe.)

FIGURE 4



ADJUST CONTACT POINT OPENING

JOB SHEET #10

R. Adjust contact points to manufacturer's recommendations

S. Tighten contact point attaching screws securely; recheck contact point opening

T. Install rotor

(NOTE: Make sure the rotor is positioned correctly and is securely in place.)

U. Install distributor cap

(NOTE: Make sure the distributor is positioned correctly and is securely in place.)

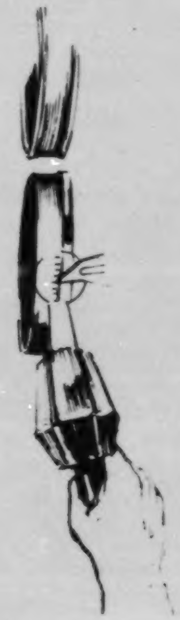
V. Replace distributor in engine, if removed

W. Start engine

X. Set timing to manufacturer's specifications (Figure 5)

FIGURE 5

TIMING



BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #11--ADJUST DWELL ON AN EXTERNALLY ADJUSTABLE DISTRIBUTOR

I. Tools and materials

  A. Dwell meter

  B. Hex contact point adjusting tool

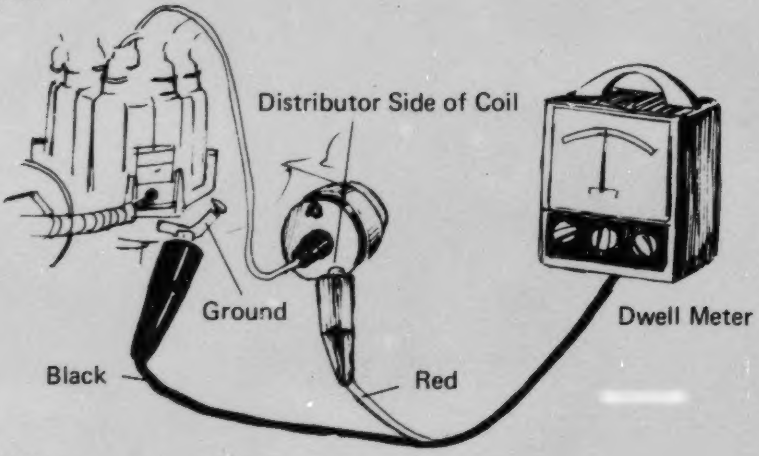
  C. Safety glasses

II. Procedure

  A. Connect dwell meter (Figure 1)

  (CAUTION: Observe correct hookup procedures and position wires away from moving engine parts.)

FIGURE 1



  (NOTE: Be sure to disconnect vacuum line.)

  B. Refer to manufacturer's specifications for desired dwell setting

  C. Start the engine

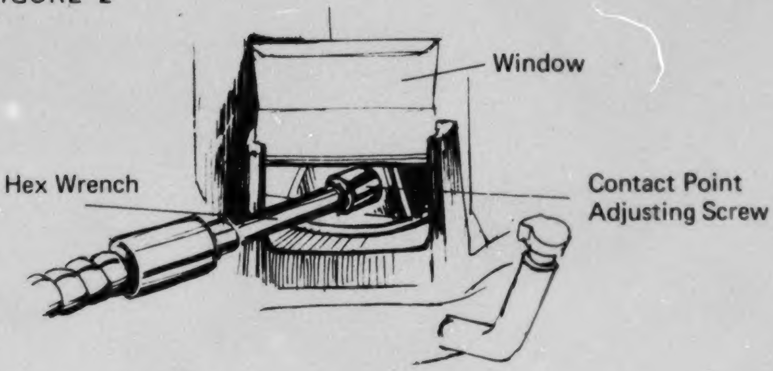
  D. Adjust idle speed to manufacturer's specifications

  E. Raise distributor cap adjustment window

JOB SHEET #11

F. Insert hex wrench into contact point adjustment screw (Figure 2)

FIGURE 2


Window
Hex Wrench
Contact Point
Adjusting Screw

G. Adjust contact point dwell while observing dwell meter reading to comply with manufacturer's specifications

(NOTE: Recheck engine idle speed.)

H. Remove hex wrench and recheck dwell reading

I. Shut off the engine

J. Remove dwell meter

K. Push window on distributor cap down securely

(NOTE: Connect vacuum line to distributor.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #12--CHECK AND SET IGNITION TIMING

I. Tools and materials

   A. Timing light

   B. Combination end wrenches, 7/16" - 9/16"

   C. Special distributor wrenches as required

   D. Chalk

   E. Shop towels

   F. Safety glasses

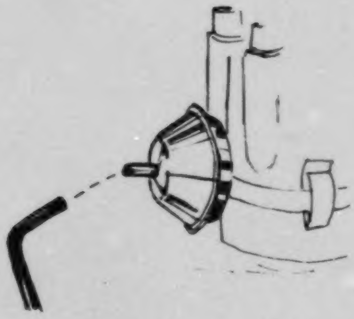
II. Procedure

   A. Obtain manufacturer's specifications for ignition timing, dwell, and rpm

   (NOTE: Rpm and dwell must be set to manufacturer's specifications before timing is set.)

   B. Remove vacuum line at the distributor (Figure 1)

FIGURE 1



REMOVE VACUUM LINE

   C. Locate and clean the ignition timing marks on the harmonica balancer; mark with chalk

   D. Locate and clean the timing pointer or the plate on the front cover

JOB SHEET #12

E. Connect the timing light according to the instructions for the light being used

(NOTE: When making connections, do not puncture spark plug cables with pins or clips.)

F. Position wires away from moving engine parts

G. Start the engine

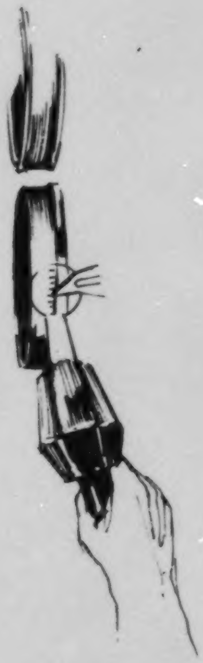
H. Make sure the engine is idling at manufacturer's recommendations

(NOTE: The engine must idle correctly to prevent incorrect timing caused by the centrifugal advance.)

I. Direct the timing light toward the timing marks (Figure 2)

(NOTE: If the timing is correct, the timing marks will line up at the check point. If the timing is incorrect, proceed as follows.)

FIGURE 2



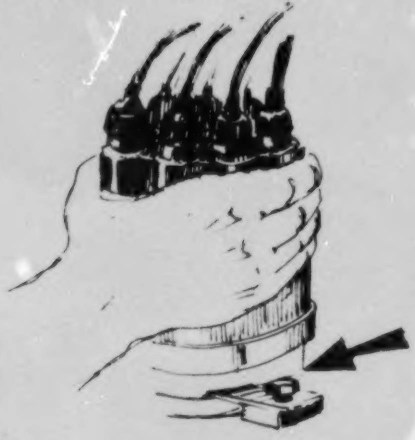
CHECK TIMING

J. Loosen the clamp or lock screw on the distributor

JOB SHEET #12

K. Move the distributor until the timing marks are lined up (Figure 3)

FIGURE 3



MOVE DISTRIBUTOR TO ADJUST TIMING

L. Tighten the clamp or lock screw on the distributor

M. Recheck timing

N. Shut off engine

O. Disconnect timing light

(NOTE: Remove timing light adapter on spark plug if used.)

P. Replace vacuum line on distributor

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #13--REMOVE, SERVICE, AND REPLACE SPARK PLUGS

I. Tools and materials

- A. Spark plug socket, 3/8" drive
- B. Ratchet, 3/8" drive
- C. Extensions, 3", 6", 10", by 3/8" drive
- D. Spark plug cleaner
- E. Wire brush
- F. Small point file
- G. Shop towels
- H. Safety glasses
- I. Torque wrench

II. Procedure

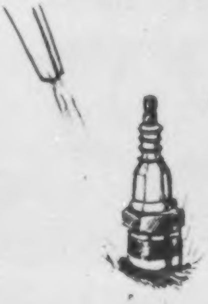
- A. Remove spark plug wires

  (NOTE: Pull the wire from the spark plug by grasping the terminal, not by pulling on the wire.)

- B. Loosen the spark plugs
- C. Clean the area around the spark plug by blowing, wiping, or brushing (Figure 1)

  (NOTE: Wear safety glasses to protect your eyes when using compressed air.)

FIGURE 1

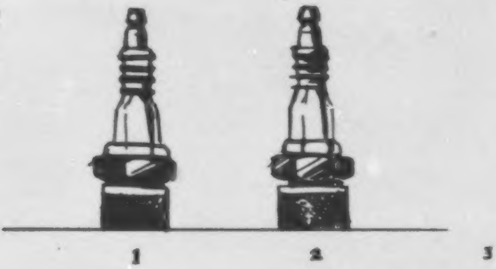


JOB SHEET #13

D. Remove the spark plugs

(NOTE: Arrange the spark plugs in order as they are removed. The condition of the spark plug can tell a lot about the operation of a particular cylinder. See Figure 2.)

FIGURE 2



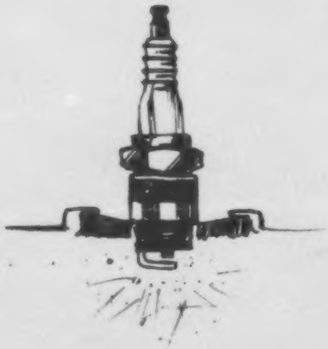
ARRANGE IN ORDER

E. Remove the spark plug gaskets if used

F. Determine the condition of the spark plugs and decide whether to replace or service

G. Service by cleaning the spark plugs on a spark plug cleaning machine (Figure 3)

FIGURE 3

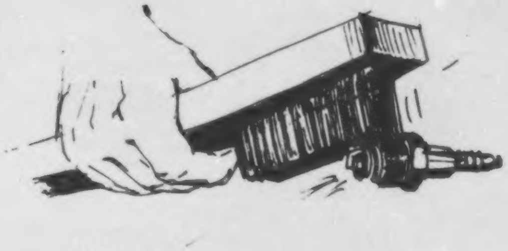


CLEAN SPARK PLUGS

JOB SHEET #13

H. Clean the thread with a wire hand brush (Figure 4)

FIGURE 4

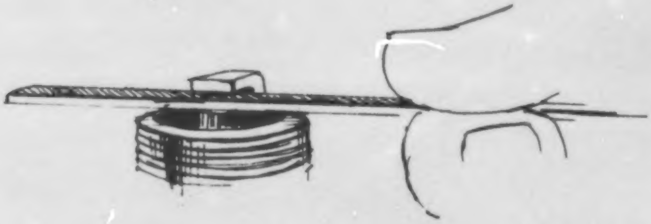


CLEAN SPARK PLUG THREADS

I. Bend the ground electrode slightly to open gap

J. File the center electrode to flatten the surface and square up the edges (Figure 5)

FIGURE 5



FILE CENTER ELECTRODE FLAT

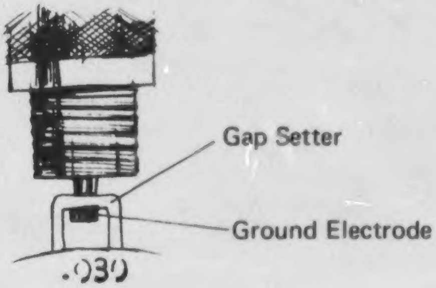
K. Reset gap on new and serviced spark plugs to manufacturer's specifications (Figure 6)

(NOTE: Use a wire gauge to check the gap. Make sure the electrode surfaces are parallel. Regap everytime plugs are serviced.)

(CAUTION: Bend only the ground electrode.)

FIGURE 6

RESET SPARK PLUG GAP



L. Install new spark plug gaskets if required

M. Install spark plugs and tighten

(NOTE: To avoid cross threading, use caution when starting to install the spark plugs.)

N. Torque the spark plugs to manufacturer's recommendations

O. Replace the spark plug wires in the proper order

(NOTE: Push the spark plug wires securely into place making sure that they are in the brackets or holders.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #14--CHANGE OIL IN AN ENGINE

I. Tools and equipment

- A. Drain pan
- B. Wrench suitable for drain plug removal
- C. Jack
- D. Jack stands, 4
- E. Oil spout
- F. Service sticker
- G. Shop towels

II. Procedure

(CAUTION: Never get under improperly supported vehicle.)

A. Support vehicle on jack stands

B. Position drain pan under engine drain plug

C. Remove drain plug

(CAUTION: Use care to avoid being burned by hot oil.)

D. Allow the oil sufficient time to drain

(NOTE: Observe oil condition and color that might make further service necessary.)

E. Replace oil filter as required

F. Replace drain plug

(NOTE: Make sure the gasket, if used, is in place and the drain plug is securely tightened.)

G. Remove jack stands and lower vehicle to floor

H. Lift hood

I. Remove oil filler cap

(NOTE: Dirt and grease should be wiped away from filler cap before removal.)

JOB SHEET #14

J. Refill crankcase to recommended level with the proper motor oil

(NOTE: Make sure the tops of the oil cans and the filling spout are clean.)

K. Clean and replace oil filler cap

L. Start engine and operate it for a few minutes at low rpm

M. Check for oil leaks

N. Shut off engine

O. Check oil level on dipstick

(NOTE: Add oil as required by manufacturer's specifications. Do not overfill.)

P. Make out service chart

(NOTE: Make sure that date, hour meter reading, and type of oil are included on service chart.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

JOB SHEET #15--CHANGE AN OIL FILTER

I. Tools and equipment

   A. Shop towels

   B. Container to catch waste oil

   C. Suitable wrenches to remove filter

   D. Fender covers

   E. Suction gun

   F. Jack

   G. Jack stands, 4

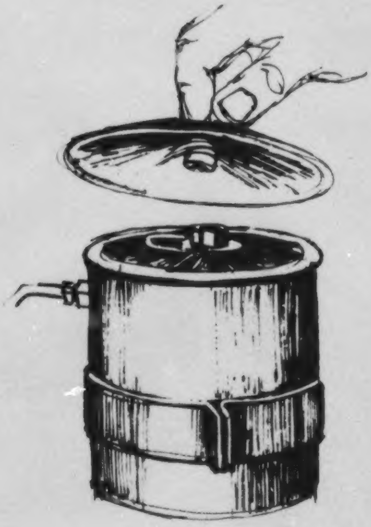
II. Procedure

   A. Replaceable element-type oil filter on upper part of engine

      1. Clean dirt from filter cover

      2. Remove oil filter cover (Figure 1)

FIGURE 1



JOB SHEET #15

3. Remove oil filter element

   (NOTE: Use care to avoid spilling oil on vehicle.)

4. Remove remaining oil from filter housing by removing drain plug from housing, or use the suction gun to draw out the oil

5. Clean filter cover and housing

6. Remove old filter gasket

7. Install new filter gasket into filter cover

   (NOTE: Install other small rubber gaskets as required.)

8. Install new filter element

9. Install filter cover

   (NOTE: Make sure the gasket is in place.)

10. Tighten filter cover securely

11. Add oil or refill crankcase as required

12. Start engine

13. Check for leaks

14. Shut off engine

15. Check oil level on dipstick

    (NOTE: Add oil as required. Do not overfill.)

16. Make out service chart, indicating mileage and date that oil filter was changed

B. Replaceable element-type oil filter on lower part of engine

1. Support front of vehicle on jack stands

   (CAUTION: Never get under improperly supported vehicle.)

2. Position drain pan under oil filter

3. Remove oil filter housing bolt

4. Remove oil filter housing

JOB SHEET #15

5. Remove oil filter element from filter housing (Figure 2)

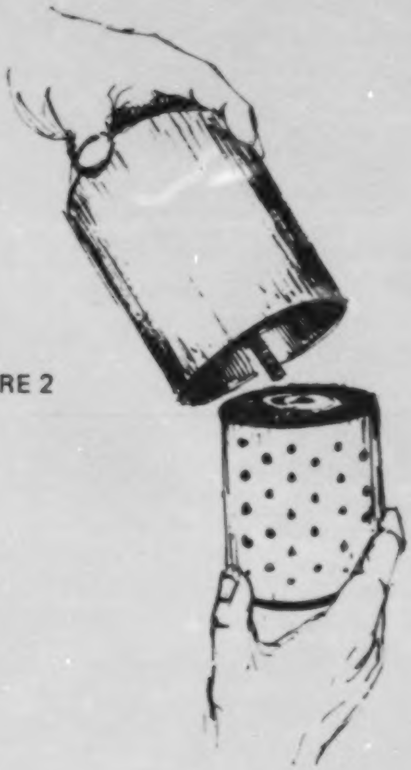


FIGURE 2

6. Clean the filter housing
7. Remove old oil filter housing gasket
8. Install new oil filter housing gasket

   (NOTE: Make sure the new gasket is placed correctly.)
9. Install new oil filter element in filter housing
10. Install oil filter housing and tighten bolt securely
11. Remove jack stands and lower vehicle to floor
12. Add oil or refill crankcase if required
13. Start engine
14. Check for leaks

JOB SHEET #15

15. Shut off engine
16. Check oil level on dipstick

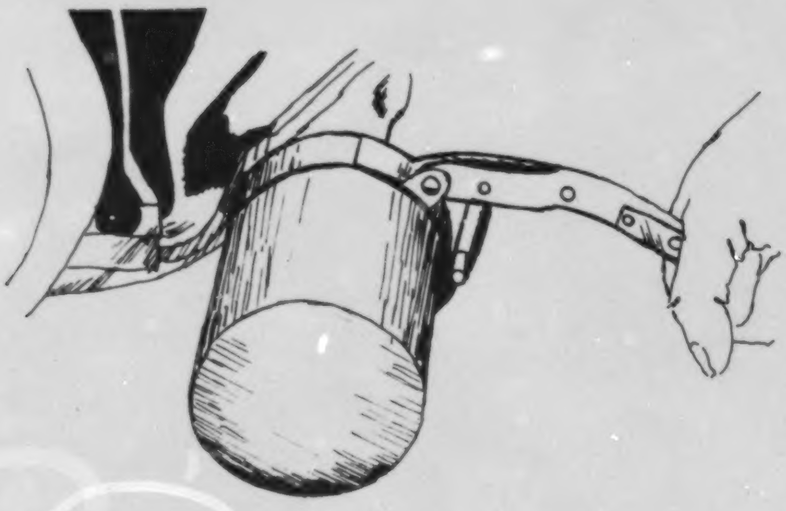
    (NOTE: Add oil if required. Do not overfill.)
17. Make out service chart, indicating hour meter reading and date that oil filter was changed

C. Sealed cartridge-type oil filter

1. Support front of vehicle on jack stands if required
2. Place drain pan under oil filter
3. Remove oil filter cartridge with suitable tool (Figure 3)

    (NOTE: Turn counterclockwise to remove.)

FIGURE 3

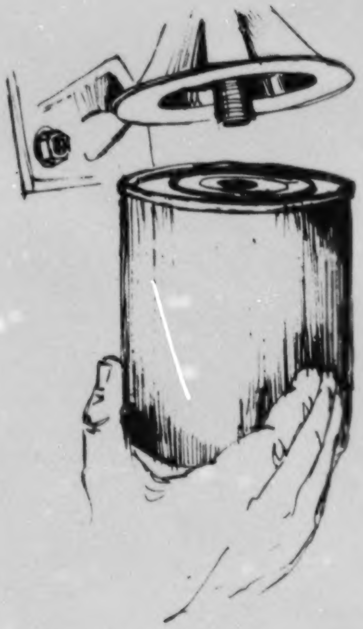


4. Lubricate the sealing gasket on the new oil filter cartridge with clean motor oil if required

JOB SHEET #15

5. Replace oil filter cartridge; tighten to manufacturer's recommendation (Figure 4)

FIGURE 4



CHANGING SEALED CARTRIDGE OIL FILTER

(NOTE: Usually hand tightening is sufficient.)

6. Remove jack stands and lower vehicle to floor
7. Add oil or refill crankcase as required
8. Start engine
9. Check for leaks
10. Shut off engine
11. Check oil level on dipstick

    (NOTE: Add oil if required. Do not overfill.)

12. Make out service chart, indicating hour meter reading and date that oil filter was changed

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

TEST

NAME_______________________________ SCORE________

1. Match terms associated with basic principles of engines to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Reduction of volume of gases trapped in cylinder by upward motion of piston

_____b. Series of events that repeat themselves in a regular sequence

_____c. Distance piston moves when traveling from TDC to BDC

_____d. Top dead center

_____e. Bottom dead center

_____f. Ratio of whole cylinder volume to clearance volume

_____g. Total space between piston at BDC and cylinder head

_____h. Total space between piston at TDC and cylinder head

_____i. Liquid that circulates through cooling system to transfer engine heat

_____j. Heat-controlled valve in the cooling system used to regulate the flow of coolant between cylinder block and radiator

_____k. Radiator cap which increases pressure within cooling system several psi, allowing coolant to circulate at higher temperatures without evaporation or surge loss

_____l. Pounds per square inch

_____m. Device that atomizes fuel and sprays it into combustion chamber

_____n. To reduce a liquid to a fine spray

1. TDC
2. Volume
3. psi
4. Compression
5. Thermostat
6. BDC
7. Atomize
8. Viscosity
9. Cycle
10. Dwell
11. Compression ratio
12. Coolant
13. Injection nozzle
14. Stroke
15. SAE number
16. Pressure cap
17. Clearance volume
18. Eccentric

_____o. Number of degrees of distributor cam rotation that ignition points are closed

_____p. Measure of ability of an oil to resist flowing

_____q. Classification of motor, transmission, and differential lubricants to indicate viscosities standardized by the Society of Automotive Engineers

_____r. Disc or offset section (of a shaft) used to convert rotary to reciprocating motion (cam)

_____s. Substance added to cooling system to lower its freezing point

_____t. Potential difference or electromotive force measured in volts

_____u. Flow of electric charge

_____v. Property of a conductor by which it opposes the flow of an electric current, resulting in generation of heat in conducting material

_____w. Standard unit for measuring the strength of an electric current; rate of flow of charge in a conducting medium of one coulomb per second

_____x. A wire, cable, or other body or medium suitable for carrying electric current

_____y. Method of pushing air out of the cylinders during the exhaust stroke on two-cylinder engines

_____z. Unit of electrical resistance equal to the resistance through which a current of one ampere will flow when there is a potential difference of one volt across it

_____aa. Unit of potential difference or electromotive force equal to the potential difference between two points for which one couloumb of electricity will do one joule of work in going from one point to the other

_____bb. Charge transported through a conductor by a current of one ampere flowing for one second; this is the legal standard of electricity

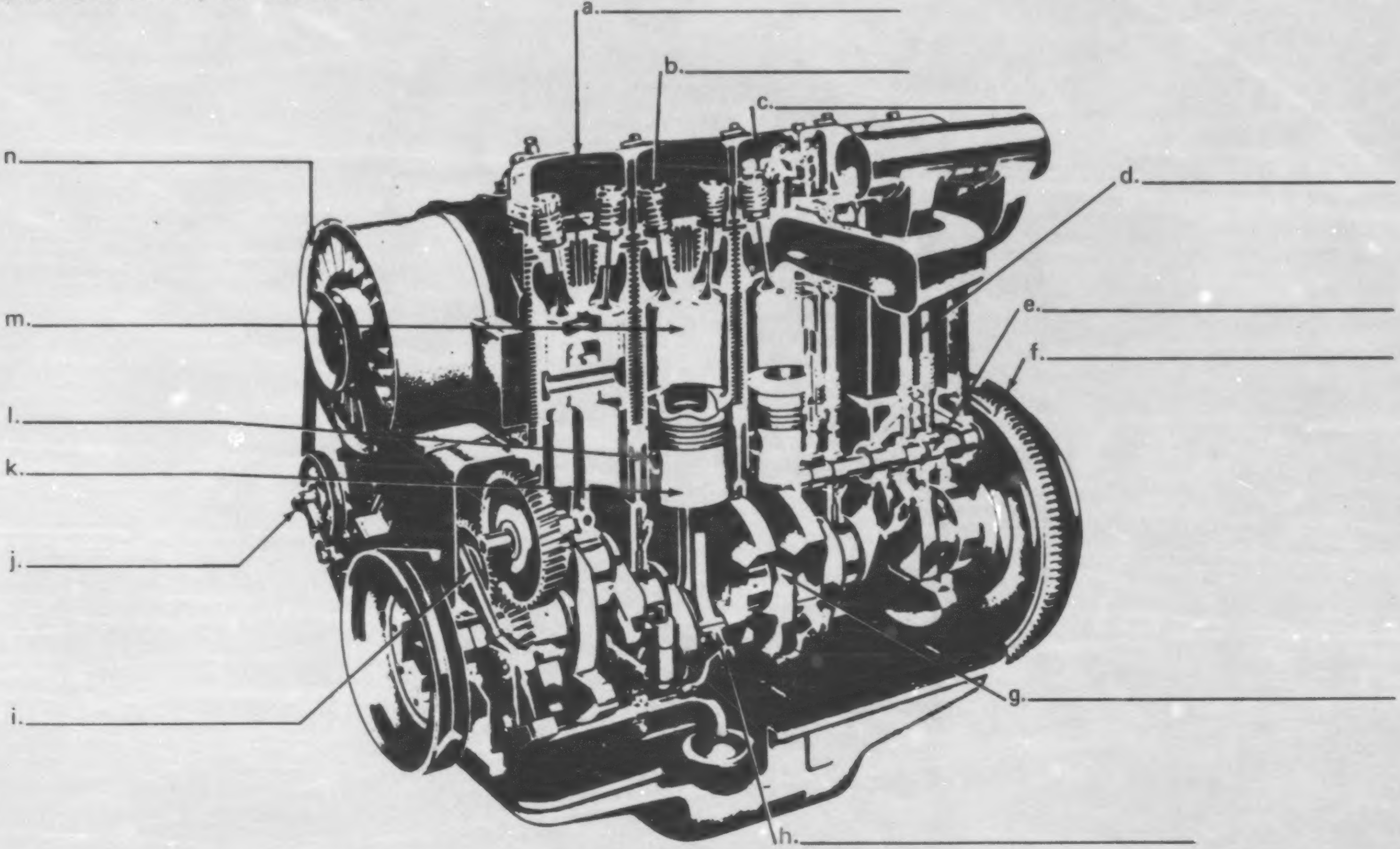
_____cc. Newton-meter of energy

_____dd. The unit of force in the mks (meter-kilogram-second) system

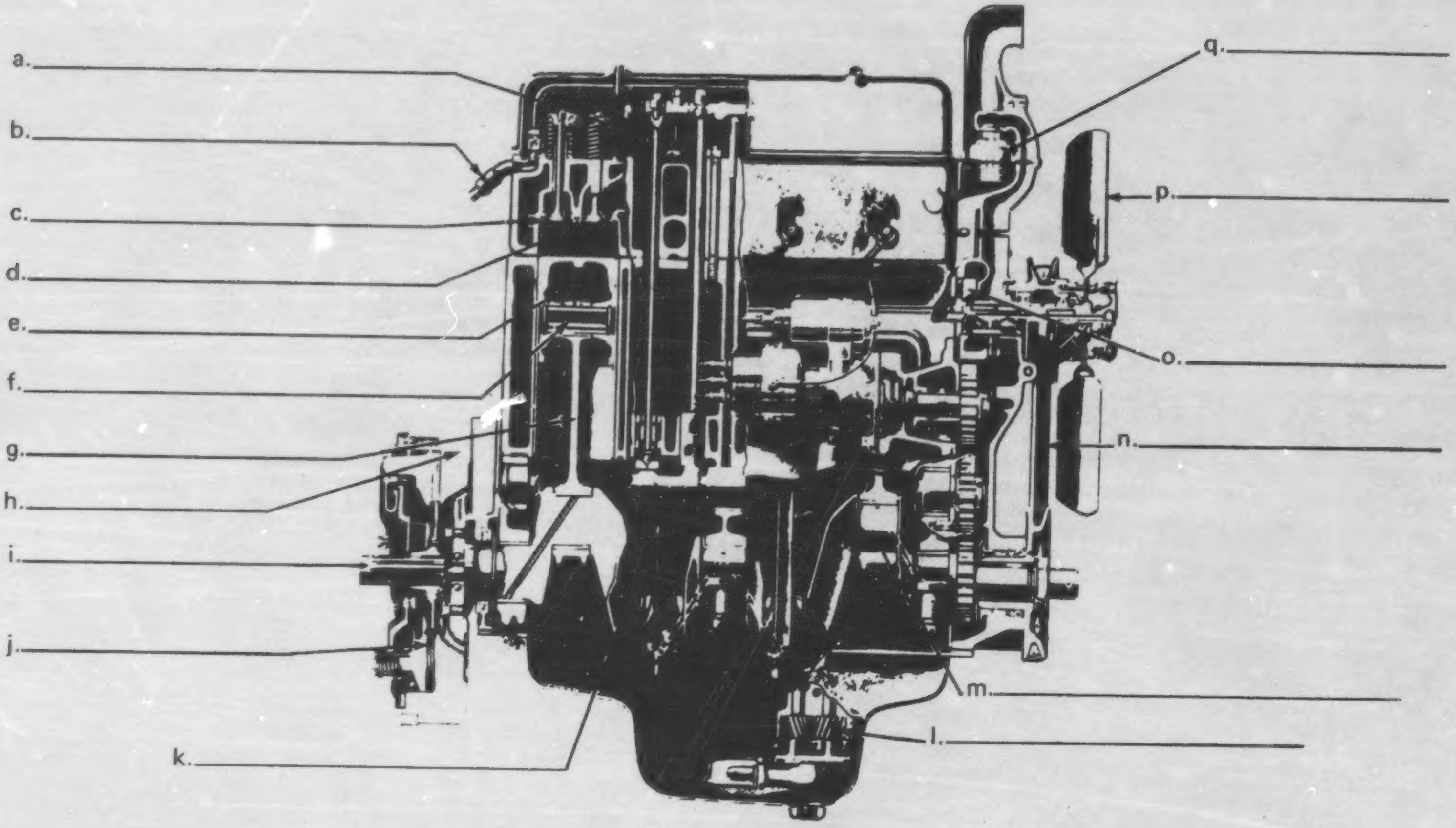
19. Current
20. Ohms
21. Coulomb
22. Newton
23. Antifreeze
24. Joule
25. Conductors
26. Resistance
27. Volt
28. Voltage
29. Ampere
30. Scavenge

2. Identify basic parts of the following diesel and gasoline engines. Write the correct names in the blanks provided.

DIESEL ENGINE (AIR COOLED)



GASOLINE ENGINE (INDUSTRIAL)


a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.
m.
n.
o.
p.
q.

3. Arrange in order the strokes in a two-stroke or four-stroke engine beginning with intake stroke. Write "1" in the blank before the first procedure, "2" in the blank before the second procedure, and so on.

   ______a. Power (ignition)

   ______b. Intake

   ______c. Exhaust

   ______d. Compression

4. Distinguish basic differences between a gasoline engine and a diesel engine.

   a. Gasoline

      1) ____

      2) ____

      3) ____

      4) ____

   b. Diesel

      1) ____

      2) ____

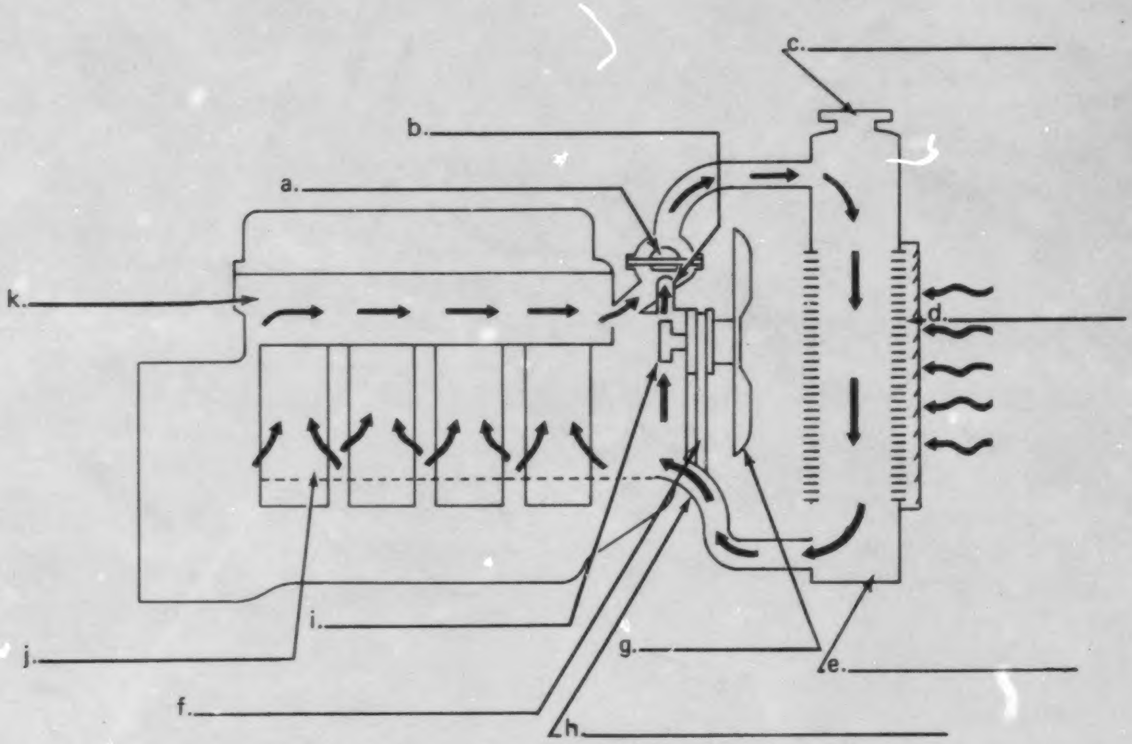
      3) ____

      4) ____

5. Identify components of the cooling system illustrated below. Write the correct names in the blanks provided.

Pressure cap
Thermostat
Engine water jacket
Bypass
Radiator
Fan belt

Coolant
Air flow
Fan
Water pump
Radiator hose



6. Match types of cooling systems to their correct uses. Write an "L" in the blank pertaining to liquid and an "A" in the blank pertaining to air.

______a. Uses a fan

______b. Uses circulating coolant

7. Select from the following list requirements of a good coolant. Write an "X" in the correct blanks.

______a. Conductor of electricity

______b. Non-conductor of heat

______c. Chemically stable

______d. Causes freezing

______e. Flows readily at all temperatures

______f. Resists foaming

______g. Causes rust and corrosion

______h. Lubricates radiator

8. Describe operation of thermostat when engine is cold and when engine is at operating temperature.

a. Engine cold-- ____

____

b. Engine at operating temperature-- ____

____

9. Select from the following list preventive maintenance procedures. Write an "X" in the correct blanks.

______a. Check coolant as recommended in operator's manual

______b. Shut engine off immediately after stopping

______c. Back-flush system daily

______d. Flush and clean system periodically

______e. Inspect for system deterioration

______f. Tighten fan belts periodically

______g. Lubricate water pump and fan, as required

______h. Remove pressure cap while engine is hot

10. Distinguish between fuel systems components for gasoline and diesel engines. Write a "G" in blanks pertaining to gasoline, a "D" in blanks pertaining to diesel, and a "GD" in blanks pertaining to both.

_____a. Fuel filter

_____b. Carburetor

_____c. Fuel tank

_____d. Fuel injection pump

_____e. Fuel pump

_____f. Air cleaner

_____g. Fuel lines

_____h. Fuel injection nozzle

11. Match gasoline engine and diesel engine fuel systems to their proper functions. Write a "G" in the blank that describes gasoline engine and a "D" in the blank that describes diesel engine.

_____a. Pumps fuel at low pressure from tank through filters to injection pump where it times the fuel delivery and measures and delivers fuel under pressure to injection nozzle where it is atomized and sprayed into combustion chamber

_____b. Pumps fuel from tank through filters into carburetor where it is mixed with air in proper proportion for a combustible mixture and then delivered to cylinders

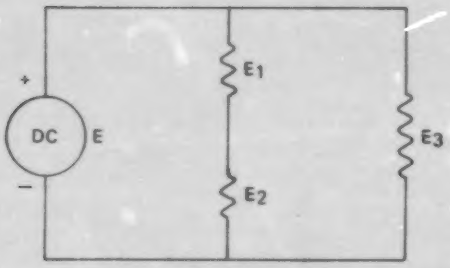
12. Distinguish among types of air cleaners. Write a "D" in the blank representing dry element, a "V" in blank representing viscous-impingement, and an "O" in blank representing oil bath.

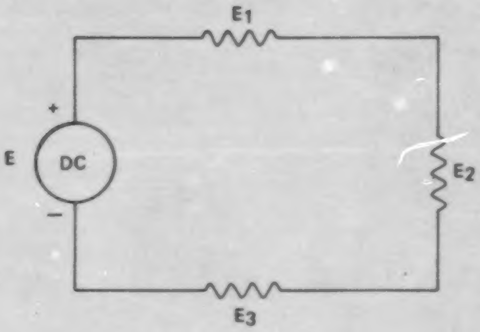
_____a. Cleans by passing air through a maze of metal wool, wire, or screens saturated with oil

_____b. Cleans by directing air through a center tube into inner oil cup where direction of air flow is reversed causing most dirt to become trapped by the oil and settle in the sump

_____c. Cleans by replacing element

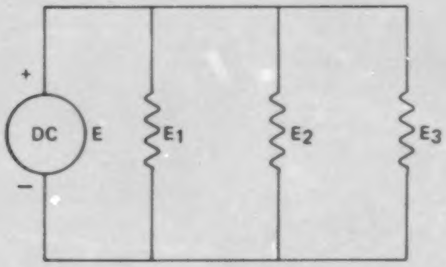
13. Label types of electrical circuits illustrated below. Write the correct names in the blanks provided.





a. ______________________________

b. ______________________________



c. ______________________________

14. Select from the following list factors that affect resistance in a conductor. Write an "X" in the correct blanks.

_____a. Cross-sectional area

_____b. Temperature

_____c. Weight

_____d. Length

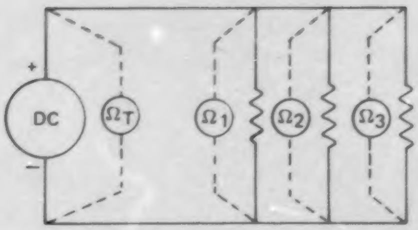
_____e. Material

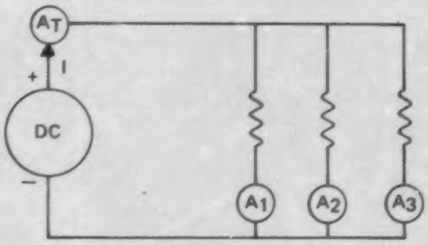
15. Complete Ohm's law chart illustrated below. Write the correct answer in the blank spaces.

a. ________ = $\frac{\text{Voltage}}{\text{Resistance}}$	$I = \frac{E}{R}$	Amperes = $\frac{\text{Volts}}{\text{d. ________}}$
Voltage = Current x b. ________	$E = IR$	e. ______ = Amperes x Ohms
Resistance = $\frac{\text{c. ________}}{\text{Current}}$	$R = \frac{E}{I}$	Ohms = $\frac{\text{Volts}}{\text{f. ________}}$

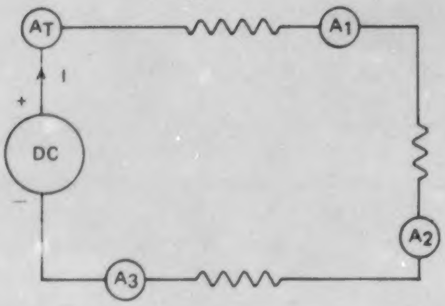
16. Match laws of circuits to their illustrations. Write the correct names in the blanks provided.

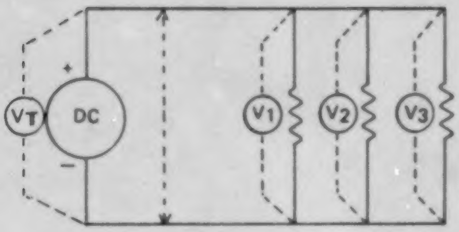
1. Series resistance
2. Parallel voltage
3. Series current
4. Parallel reesistance
5. Series voltage
6. Parallel current



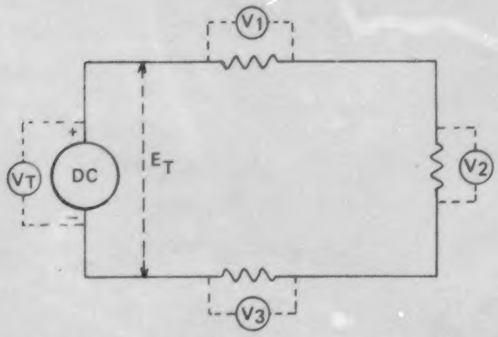


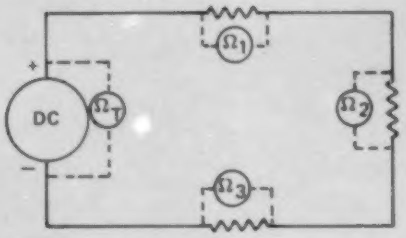
a. ______________________ b. ______________________


AT
I
+
DC
–
A1
A2
A3


+
VT
DC
–
V1
V2
V3

c. ____________________ d. ____________________


V1
+
VT
DC
–
ET
V2
V3


Ω1
+
DC
ΩT
–
Ω2
Ω3

e. ____________________ f. ____________________

17. Distinguish between direct current and alternating current. Write "DC" in the blanks pertaining to direct current, and "AC" in blanks pertaining to alternating current.

______a. Supplied by an alternating current generator

______b. Flows in one direction only

______c. Flows in one direction then reverses and flows in opposite direction

______d. Supplied by dry cell battery

______e. Supplied by a direct current generator

18. State functions of a battery.

a. ______________________________

b. ______________________________

c. ______________________________

19. Select from the following list processes by which a battery converts chemical energy into electrical energy. Write an "X" in the correct blanks.

_____a. More active metal will lose electrons and become positively charged

_____b. Two similar minerals placed in acid will produce chemical action

_____c. Two similar minerals placed in acid will not produce chemical action

_____d. Less active metal will accumulate voltage and become positively charged

_____e. Less active metal will accumulate electrons and become negatively charged

_____f. Two dissimilar metals placed in acid solution will produce chemical action

20. Select from the following list safety rules pertaining to care and maintenance of batteries. Write an "X" in the correct blanks.

_____a. Avoid breathing fumes from battery

_____b. Ground terminals to machine while servicing

_____c. Do not allow electrolyte to come in contact with eyes, skin, clothing, or painted surfaces

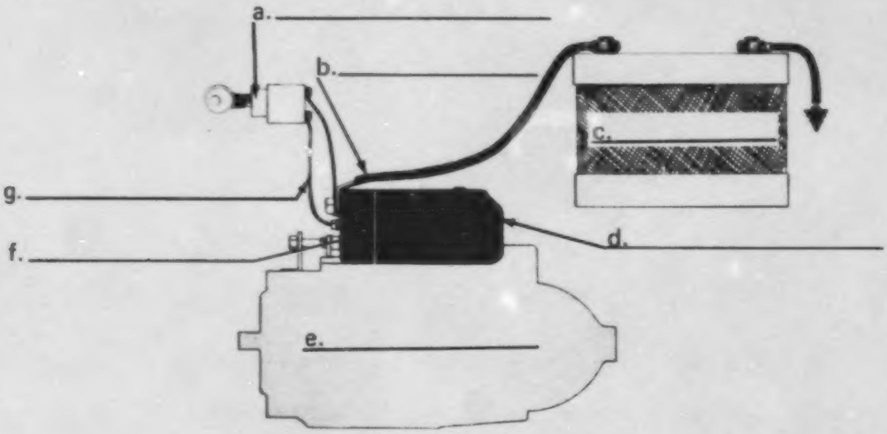
_____d. Avoid shorting or grounding battery terminals during service

_____e. Wear hard hats and safety shoes when servicing battery

_____f. Flush battery immediately if electrolyte comes in contact with it

_____g. Keep flames or sparks away from battery because gases given off by battery are very explosive

21. Label components of the starting system illustrated below. Write the correct names in the blanks provided.



22. Match major parts of starting circuit to their functions. Write the correct numbers in the blanks provided.

_____a. Supplies energy for the circuit

_____b. Activates the circuit

_____c. Closes circuit to motor and engages motor drive with flywheel

_____d. Drives flywheel to start engine

1. Motor switch
2. Starting motor
3. Starter switch
4. Battery

23. List ten components of the ignition system.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

h. ____

i. ____

j. ____

24. Arrange in order the operation of ignition system through one complete cycle, beginning with battery. Write a "1" before the first step, a "2" before the second step, and so on.

_____a. This high voltage surge is directed from the secondary windings of the coil through the distributor cap and rotor and on to the spark plug to ground

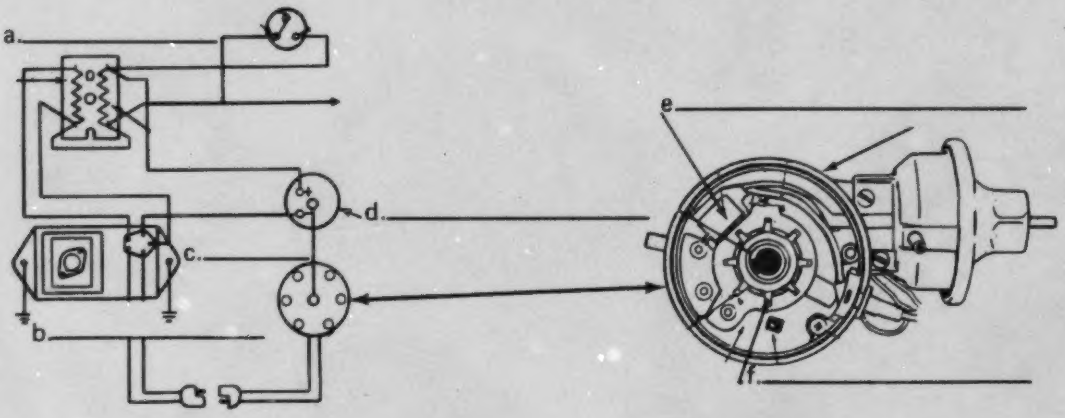
_____b. With the ignition switch on and the contact points closed, low voltage current flows from the battery through the primary winding of the coil and through the contact points to ground

_____c. The flow of low voltage current through the primary windings of the coil causes a magnetic field build-up

_____d. As the contact points open, current continues to flow across the point surfaces; the condenser attached to the points absorbs this flow of current

_____e. Stopping this flow of current causes the magnetic field of the coil primary windings to collapse across the secondary coil windings, causing a high voltage surge

25. Label major components of electronic ignition system illustrated below. Write the correct names in the blanks provided.



26. Match major components of electronic ignition system to their functions. Write the correct numbers in the blanks provided.

_____a. Maintains constant primary current with variations in engine speed

_____b. Sends a small voltage pulse to control unit which triggers switching transistor to stop current flow in the coil primary windings

_____c. Rotates with the distributor shaft, producing a voltage pulse in the magnetic pickup

_____d. Controls the flow of current in the primary windings of the ignition coil and maintains constant dwell

1. Armature or reluctor
2. Control unit
3. Magnetic pickup assembly
4. Dual ballast resistor

27. Distinguish the purpose of intake system and exhaust system in diesel engines.

a. Air intake system--________________________________

____

____

b. Exhaust system--________________________________

____

____

28. Distinguish between parts of an air intake system and parts of an exhaust system. Write an "I" in blanks pertaining to intake, and an "E" in blanks pertaining to exhaust.

______a. Turbocharger (if used)

______b. Precleaner (air cleaner)

______c. Supercharger (if used)

______d. Exhaust manifold

______e. Piping

______f. Intake valves or ports

______g. Ports and/or valves

______h. Intake manifold

29. Distinguish among the three methods of scavenging the cylinders on a two-stroke cycle engine. Write a "C" in blanks pertaining to crankcase, a "P" in blanks pertaining to power piston, and a "B" in blanks pertaining to blower.

______a. Pushes the vapor into cylinder as intake valves or ports open

______b. Compresses the vapor into air chamber surrounding intake ports

______c. Uses a positive-displacement, rotary blower driven by the engine

______d. Air enters engine through crankcase

______e. The compressed vapor escapes into the cylinder at a pressure nearly equal to atmospheric pressure

______f. Uses a separate piston and cylinder driven by engine crankshaft

30. Distinguish between port and valve scavenging in a two-cycle engine.

a. Port scavenging-- ____

____

b. Valve scavenging-- ____

____

31. Distinguish between the two types of superchargers. Write a "P" in the blanks pertaining to positive displacement and a "C" in the blanks pertaining to centrifugal.

______a. Driven by engine, engine exhaust, or separate motor

______b. Resembles oil pump in design

______c. Driven by a chain, belt, or gear

______d. Impeller normally moves thirty times engine speed

32. Select from the following list advantages of a turbocharged engine. Write an "X" in the correct blanks.

_____a. Reduces exhaust smoke by supplying excess air to reduce exhaust density

_____b. Increases horsepower output of a given displacement engine

_____c. Cost of a turbocharged engine is less

_____d. Maintains horsepower at high altitudes

_____e. Reduces weight by delivering more horsepower per pound than nonturbocharged engines

33. State three purposes of engine lubrication system.

a. ____________________

b. ____________________

c. ____________________

34. Select from the following list characteristics of good engine oil. Write an "X" in the correct blanks.

_____a. Resists corrosion and rusting

_____b. Produces sludge

_____c. Resists breakdown at high temperatures

_____d. Resists breakdown at low temperatures

_____e. Produces foam

_____f. Keeps a protective film on moving parts

_____g. Prevents carbon build-up

_____h. Produces oxidation

_____i. Flows easily at low temperatures

_____j. Resists breakdown after long use

35. List oil contaminants.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

36. Match oil additives to their functions. Write the correct numbers in the blanks provided.

______a. Helps prevent failure of alloy bearings from corrosive acids caused by combustion

______b. Prevents acid, varnish, and sludge formation

______c. Prevents rusting of metal parts during storage or down-time

______d. Helps oil give top lubricating protection at both high and low temperatures

______e. Prevents wax crystals from congealing in cold weather and forming clumps

______f. Helps keep metal surfaces clean, and prevents deposit formation

______g. Helps prevent air bubbles which would resist lubrication

1. Oxidation inhibitor
2. Detergent dispersant
3. Viscosity index improver
4. Foam inhibitor
5. Anti-corrosion
6. Anti-rust
7. Pour point depressant

37. State three general rules for selecting engine oil.

a. ____

b. ____

c. ____

38. Demonstrate the ability to:

a. Test thermostat action.

b. Test for exhaust gas leakage and air in cooling system.

c. Test antifreeze solution.

d. Service an air cleaner.

e. Clean and service a battery.

f. Remove and replace a battery.

g. Measure battery electrolyte with a hydrometer.

h. Start an engine using a negative-ground booster battery.

i. Use a twenty-four volt (24 V) battery booster system to start a vehicle with a twelve volt (12 V) system.

j. Remove and replace contact points and condenser.

k. Adjust dwell on an externally adjustable distributor.

l. Check and set ignition timing.

m. Remove, service, and replace spark plugs.

n. Change oil in an engine.

o. Change an oil filter.

(NOTE: If the activities in number 38 have not been finished before the test, ask the instructor when they should be completed.)

BASIC PRINCIPLES OF ENGINES
(GASOLINE AND DIESEL)
UNIT I

ANSWERS TO TEST

1.

a.	4	k.	16	u.	19
b.	9	l.	3	v.	26
c.	14	m.	13	w.	29
d.	1	n.	7	x.	25
e.	6	o.	10	y.	30
f.	11	p.	8	z.	20
g.	2	q.	15	aa.	27
h.	17	r.	15	bb.	21
i.	12	s.	18	cc.	24
j.	5	t.	28	dd.	22

2. DIESEL ENGINE (AIR COOLED)

a. Cylinder head
b. Exhaust valve
c. Rocker arm
d. Pushrods
e. Camshaft
f. Flywheel
g. Cranskshaft
h. Connecting rod
i. Timing gears
j. V-belt idler
k. Piston
l. Wrist pin
m. Combustion chamber
n. Cooling air blower

GASOLINE ENGINE (INDUSTRIAL)

a. Pushrods
b. Crankcase breather
c. Exhaust valve
d. Intake valve
e. Piston
j. Clutch
k. Camshaft and cams
q. Thermostat
p. Cooling fan
o. Water pump

f. Piston pin

g. Connecting rod

h. Flywheel

i. Clutch pilot shaft

n. Fan belt

m. Crankshaft

l. Gear oil pump

3. a. 3

   b. 1

   c. 4

   d. 2

4. Answer should include:

   a. Gasoline

      1) Ignition by electrical spark

      2) Takes fresh air and fuel through carburetor, and then to combustion chamber

      3) Low compression ratio (7-12:1)

      4) Burns gasoline

   b. Diesel

      1) Ignition by compression

      2) Takes fresh air directly to combustion chamber

      3) High compression ratio (16-22:1)

      4) Burns low-grade fuel oil

5. a. Thermostat

   b. Bypass

   c. Pressure cap

   d. Air flow

   e. Radiator hose

   f. Fan belt

   g. Fan

   h. Radiator

   i. Water pump

   j. Coolant

   k. Engine water jacket

6. a. A

   b. L

7. c, e, f

8. Answer should include:

    a. Engine cold--Thermostat shuts off flow of coolant from engine to radiator to allow quicker engine warm-up

    b. Engine at operating temperature--Thermostat is open and allows coolant to circulate through system

9. a, d, e, g

10. a. GD
    b. G
    c. GD
    d. D
    e. GD
    f. G
    g. GD
    h. D

11. a. D
    b. G

12. a. V
    b. O
    c. D

13. a. Series-parallel
    b. Series
    c. Parallel

14. a, b, d, e

15. a. Current
    b. Resistance
    c. Voltage
    d. Ohm's
    e. Volts
    f. Amperes

16. a. Parallel resistance
    b. Parallel current
    c. Series current

d. Parallel voltage

e. Series voltage

f. Series resistance

17. a. AC

b. DC

c. AC

d. DC

e. DC

18. a. Supplies current for cranking engine

b. Supplies current when demand exceeds ouptput of charging system

c. Stabilizes voltage in system during operation

19. a, e, f

20. a, c, d, g

21. a. Key switch

b. Battery cable

c. Battery

d. Solenoid

e. Starter

f. Starter switch

g. Small gage switch wire

22. a. 4

b. 3

c. 1

d. 2

23. Any ten of the following:

a. Battery

b. Ignition switch

c. Primary resistance unit

d. Ignition coil

e. Contact points (breaker points)

f. Condenser

g. Distributor

h. Breaker cam

i. Spark advance mechanism

j. Rotor

k. Distributor cap

l. Spark plug

m. Primary ignition wire

n. Secondary ignition wire

24. a. 5
    b. 1
    c. 2
    d. 3
    e. 4

25. a. Dual ballast resistor
    b. Control unit
    c. Distributor
    d. Ignition coil
    e. Magnetic pickup assembly
    f. Armature or reluctor

26. a. 4
    b. 3
    c. 1
    d. 2

27. Answer should include:

    a. To supply air (oxygen) for burning the fuel in the combustion chamber

    b. To scavenge the exhaust gases efficiently from combustion chamber and conduct them to the outside air with a minimum of noise

28. a. E
    b. I
    c. I
    d. E
    e. E-I
    f. I
    g. E
    h. I

29. a. P
    b. B
    c. B
    d. C
    e. C
    f. P

30. Answer should include:

    a. Air enters and gas leaves through ports in the cylinder block or liner which the piston uncovers

    b. Air enters through ports in the cylinder block, and gases leave through valves in the cylinder head

31. a. C

b. P

c. P

d. C

32. a, b, d, e

33. Any three of the following:

a. Lubricates moving parts to minimize friction

b. Acts as cooling agent to remove heat from moving parts

c. Forms a seal between piston rings and cylinder walls

d. Keeps parts clean

e. Absorbs shock between bearings and other parts

34. a, c, f, g, i, j

35. a. Foreign particles

b. Water

c. Antifreeze

d. Fuel

e. Oxidation

36. a. 5

b. 1

c. 6

d. 3

e. 7

f. 2

g. 4

37. Any three of the following:

a. Use brands of proper service rating recommended by manufacturer

b. Select brands that have been service tested

c. Never mix oils of various SAE or viscosity ratings

d. Use oil of proper viscosity for average temperature at which the vehicle will operate

38. Performance skills evaluated to the satisfaction of the instructor

DRIVE TRAIN
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify components of a drive train (power train), and state the purpose of each component. This knowledge will be evidenced by completion of assignment sheets, job sheets, and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with drive train to the correct definitions.
2. List components of a drive train (power train).
3. Identify components of clutch assembly.
4. Label parts of double plate clutch.
5. Describe engaged and disengaged clutch operation.
6. Distinguish difference between mechanical and hydraulic methods used to actuate clutch release.
7. Match clutch malfunctions to probable causes.
8. Select from a list conditions to look for during clutch inspection.
9. Describe clutch brake.
10. Discuss purpose of a transmission.
11. Label parts of transmission.
12. Identify parts of synchronizer.
13. Explain how to shift gears when machine is moving.
14. Discuss how shifting is done.
15. Label planetary gear set components.
16. Select from a list planetary gear set characteristics.
17. List available planetary gear combinations.
18. Select from a list gear ratio principles.
19. Describe the direct drive mode.
20. Describe the speed reduction mode.

21. Describe the reverse gear mode.
22. Match results to the operating conditions of a planetary gear set.
23. Identify the planetary gear set controls and components used in automatic transmissions.
24. Identify components of a planetary or sun gear set found in a differential.
25. Explain how reduction in speed and increase in torque is accomplished.
26. Identify components of an axle housing and final drive.
27. Label components of a propeller shaft (drive shaft).
28. Identify types of U-joints.
29. Label major components of a four-wheel drive vehicle.
30. Discuss purposes of torque convertors.
31. Match basic components of a torque converter to their purposes.
32. Discuss purposes of the stator.
33. State principles of torque multiplication.
34. Select from a list causes of overheating in a torque converter.
35. Select from a list characteristics of hydraulics.
36. Label components of a basic hydraulic system.
37. Name types of hydraulic systems.
38. Select from a list functions of the hudraulic system.
39. Label types of hydraulic control valves.
40. Distinguish between mechanical and hydraulic balanced directional control valves.
41. Demonstrate the ability to:
    a. Adjust clutch linkage free travel.
    b. Shift a power shift transmission.

DRIVE TRAIN
UNIT II

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

- A. Order Film(s)

  (NOTE: Engine manufacturers are excellent sources for slide and film presentations on drive train. Write directly to the appropriate company or manufacturer.)

- B. Provide students with objective sheet.
- C. Provide students with information and job sheets.
- D. Make transparencies.
- E. Discuss unit and specific objectives.
- F. Discuss information sheets.
- G. Demonstrate procedures outlined in job sheets.
- H. Give test.

II. Instructional materials:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
  1. TM 1--Clutch Assembly
  2. TM 2--Double Plate Clutch
  3. TM 3--Clutch Operation
  4. TM 4--Clutch Inspection
  5. TM 5--Clutch Inspection (Continued)
  6. TM 6--Parts of the Transmission
  7. TM 7--Parts of a Typical Synchronizer
  8. TM 8--Planetary Gear Set Components
  9. TM 9--Direct Drive Mode
  10. TM 10--Speed Reduction Mode

11. TM 11--Reverse Gear Mode
12. TM 12--Operating Conditions and Results of a Planetary Gear Set
13. TM 13--Brake Band and Clutch
14. TM 14--Propeller Shaft Components
15. TM 15--Types of U-Joints
16. TM 16--Components of the Drive Train on a Four-Wheel Drive Vehicle
17. TM 17--Torque Converter Construction
18. TM 18--Torque Multiplication
19. TM 19--Torque Multiplication (Continued)
20. TM 20--Basic Hydraulic System
21. TM 21--Types of Valves
22. TM 22--Balanced Valve Operation

D. Job sheets

1. Job Sheet #1--Adjust Clutch Linkage Free Travel
2. Job Sheet #2--Shift a Power Shift Transmission

E. Test

F. Answers to test

III. Unit references:

A. Armstrong, Ivan. *Auto Mechanics II.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1978.

B. Nichols, Herbert L., Jr. *Heavy Equipment Repair.* Greenwich, Connecticut: North Castle Books, 1969.

C. Nichols, Herbert L., Jr. *Moving the Earth.* 3rd ed., Greenwich, Connecticut: North Castle Books, 1976.

DRIVE TRAIN
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Drive train--System connecting engine to drive wheels; transfers power from power source to wheels and/or tracks

B. Clutch disc--Plate which provides friction between pressure plate and flywheel

C. Pressure plate--Housing, spring, and plate assembly which provide pressure to clamp clutch disc between pressure plate and flywheel

D. Release bearing (throwout bearing)--Bearing which provides a method of releasing the pressure plate spring pressure

E. Release fork--Y-shaped lever inside clutch housing used to engage and disengage clutch

F. Flywheel--Heavy metal disc which has a friction surface for clutch plate, and supports all clutch components

G. Linkage--Any series of rods, pedals, or levers used to transmit motion from one unit to another

H. Free travel--Amount of clutch pedal movement before release bearing contacts pressure plate fingers

I. Pressure plate fingers--Lever assembly giving mechanical advantage to pressure plate springs to release clutch plate

J. Double clutching--Engaging and disengaging clutch while in neutral to slow down jackshaft for smooth engagement of gears

K. Propeller shaft (drive shaft)--Shaft connecting transmission to the differential

L. Differential--Unit that drives both rear wheels at the same time but allows them to turn at different speeds when making turns

M. Power shift--Transmission that can be shifted while transmitting full engine power to axles

(CAUTION: When towing a machine, be sure to disconnect the drive shaft or keep the input shaft turning at a sufficient speed to provide oil pressure.)

N. Phasing--To adjust to a synchronized condition

O. Yoke--"Y" or two-pronged connection on drive shaft

P. Cross bearing race--Inner and outer rings of the U-joint bearings

INFORMATION SHEET

Q. Creeper--Platform with roller-type feet used to lie on while working overhead under equipment

R. Center punch--Tool made from a short steel rod, sharpened on one end and used to make a mark on or small impression in metal

S. Shim--Thin, often tapered, piece of material used as a spacer to adjust or make slight corrections

T. Master cylinder--The part of the hydraulic system in which pressure is generated

U. Slave cylinder--A cylinder which is controlled by or through another unit of the same type

V. Spline--Slot or groove cut in a shaft or bore

W. Torque--Turning or twisting force

X. Jackshaft--Intermediate driving shaft

Y. Trunnion--Either of two opposite pivots, or cylindrical projections, on each side of a part or assembly; used to provide a means of swiveling or turning the part or assembly

Z. Snap ring--Split ring that is snapped into a groove in a shaft or hole; used to hold in place bearings, thrust washers, gears, and so on

AA. Planetary gear set--Assembly of gears whose organization resembles the solar system

BB. Pinion gear--Smallest gear of a system

CC. Pinion carrier--Device that locates and carries the planet pinion gears

(NOTE: The pinion carrier is also known as *carrier, planet pinion cage,* or *spider.*)

DD. Gear ratio--Relationship between the number of turns made by a driving gear and one complete turn of the driven gear

EE. Ring gear--Gear shaped like a ring

(NOTE: The ring gear is also known as *internal or annalus gear.*)

FF. Sun gear--Center gear of planetary gear set that meshes with the planet pinion gears

II. Components of drive train (power train)

A. Torque converter

B. Clutch

C. Transmission

INFORMATION SHEET

- D. Propeller shaft (drive shaft)
- E. Differential
- F. Axle
- G. Wheels

III. Components of a clutch assembly (Transparency 1)

- A. Release bearing (throwout bearing)
- B. Release fork (yoke)
- C. Pressure plate
- D. Clutch disc
- E. Flywheel

IV. Parts of a double plate clutch (Transparency 2)

- A. Brake plate
- B. Pin
- C. Return spring
- D. Release lever
- E. Rear driving plate
- F. Front driving disc
- G. Driven plate (2)
- H. Clutch shaft
- I. Ring
- J. Spring
- K. Flywheel
- L. Lined plate
- M. Spring
- N. Stud
- O. Support assembly
- P. Release bearing assembly
- Q. Clutch cover plate

INFORMATION SHEET

V. Clutch operation (Transparency 3)

  A. Engaged--Spring pressure clamps clutch disc between pressure plate and flywheel face

  B. Disengaged--Release bearing and linkage release spring pressure

VI. Methods used to actuate clutch release

  A. Mechanical--Links, levers, or rods transfer motion from clutch pedal or control lever to release fork

  B. Hydraulic--Master cylinder and slave cylinder transfer motion from clutch pedal or control lever to release fork

VII. Clutch malfunctions and probable causes

  A. Slip

    1. Pressure plate spring tension weak

    2. Excessively worn clutch disc

    3. Oil contamination

    4. Improperly adjusted clutch linkage

    5. Glazed clutch lining

  B. Drag

    1. Pressure plate not releasing due to improper linkage adjustment

    2. Broken pivots in pressure plate

  C. Grab

    1. Oil contamination

    2. Broken motor mounts

    3. Glazed clutch lining

  D. Chatter

    1. Oil contamination

    2. Glazed clutch lining

    3. Warped pressure plate or flywheel

    4. Weak pressure plate spring

  E. Freezing--Water-contaminated clutch disk rusted to flywheel and pressure plate

INFORMATION SHEET

F. Binding

  1. Worn or misaligned linkage
  2. Release bearing dragging on support

G. Bearing noise

  1. Worn or dry pilot or release bearing when clutch is disengaged
  2. Pitted clutch shaft bearing when the clutch is engaged with transmission in neutral

H. Pulsating pedal--Uneven pressure plate finger height

VIII. Conditions to look for during clutch inspection (Transparencies 4 and 5)

  A. Normal finger wear
  B. Excessive finger wear
  C. Chatter marks
  D. Excessive heat discoloration
  E. Excessive warpage
  F. Heat cracks
  G. Wear pattern from warped pressure plate or flywheel
  H. Worn clutch disc
  I. Loose or worn clutch disc hub
  J. Worn clutch shaft spline
  K. Worn pilot bearing
  L. Weak pressure plate spring tension
  M. Release fork pivot and finger wear
  N. Notched or rough release bearing support
  O. Loose nuts and/or bolts

IX. Clutch brake--Small brake that stops clutch shaft when clutch is fully disengaged, preventing shaft from spinning and delaying gear shifting

X. Purpose of a transmission--Provide a change or changes in speed-power ratio of an engine driven shaft

INFORMATION SHEET

XI. Parts of a transmission (Transparency 6)

A. Input shaft (clutch shaft)
B. Input shaft bearing retainer
C. Input shaft gear (main drive gear)
D. Second and third gear synchronizer assembly
E. Second speed gear
F. First speed gear
G. First and reverse synchronizer assembly
H. Reverse gear
I. Output shaft (main shaft)
J. Extension housing
K. Reverse idler gear
L. Reverse idler gear shaft
M. Counter or cluster gear
N. Transmission case
O. Counter shaft

XII. Parts of a synchronizer (Transparency 7)

A. Synchronizer rings
B. Insert springs
C. Inserts
D. Hub
E. Sleeve

XIII. Shifting gears when machine is moving

A. Low to high

1. Disengage engine clutch to take load off gears
2. Shift into neutral
3. If engine throttle is closed, reduce waiting period by double-clutching while in neutral
4. Shift to high gear

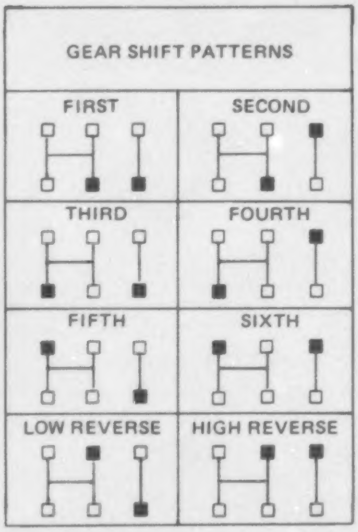
INFORMATION SHEET

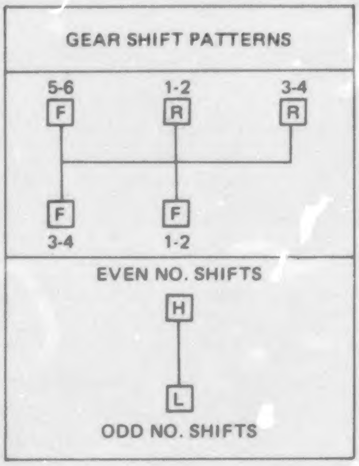
B. High to low

1. Shift to neutral
2. Engage clutch
3. Speed up engine
4. Disengage clutch
5. Complete shift

XIV. How shifting is done--Shifting is done by means of a control valve that directs hydraulic pressure to multiple disc clutches; these clutches are used to hold or release parts of the gear train to direct power through other parts

(NOTE: Shift patterns such as those in the following illustration are usually found on a plate on the vehicle dashboard.)


GEAR SHIFT PATTERNS
FIRST
SECOND
THIRD
FOURTH
FIFTH
SIXTH
LOW REVERSE
HIGH REVERSE


GEAR SHIFT PATTERNS
5-6
1-2
3-4
F
R
R
F
F
3-4
1-2
EVEN NO. SHIFTS
H
L
ODD NO. SHIFTS

XV. Planetary gear set components (Transparency 8)

A. Ring gear

B. Sun gear

C. Planet pinion gear

D. Planet pinion carrier

INFORMATION SHEET

XVI. Planetary gear set characteristics

A. Gears always in mesh

B. No side loads on gears

C. More teeth in contact for better load distribution

D. Prolonged operation in gear reduction mode not harmful

XVII. Available planetary gear combinations

A. Direct drive

B. Speed increase

C. Speed reduction

D. Reverse

E. Neutral

XVIII. Gear ratio principles

A. Increased ratio increases power output

B. Decreased ratio decreases power output

C. Increased power decreases speed

D. Decreased power increases speed

XIX. Direct drive mode--Planetary gear set turns as a unit when any two components are locked together, no matter which component is driven (Transparency 9)

Example: If the ring gear is driven, the sun gear is locked to the ring gear, and the planet pinion carrier is splined to the output shaft; then the input shaft drives the output shaft at a 1:1 ratio

XX. Speed reduction mode (Transparency 10)

A. Ring gear is driven

B. Sun gear is held

C. Planet carrier provides output torque

(NOTE: The planet pinion gears are forced to "walk" around the sun gear. The planet pinion carrier turns slower than the ring gear because of the gear-down from ring to planet gears.)

INFORMATION SHEET

XXI. Reverse gear mode (Transparency 11)

- A. Sun gear is driven
- B. Planet pinion carrier is held
- C. Planet pinion gears turn opposite sun gear
- D. Ring gear is forced by planet pinion gears to turn opposite sun gear

  (NOTE: Planet pinions can rotate on their own shafts but cannot rotate around the sun gears.)

XXII. Operating conditions and results (Transparency 12)

- A. Speed increase
  1. Ring gear is driven
  2. Sun gear is held
  3. Carrier drives
- B. Speed increase
  1. Sun gear is driven
  2. Ring gear is held
  3. Carrier drives
- C. Speed reduction
  1. Carrier is driven
  2. Sun gear is held
  3. Ring gear drives
- D. Speed reduction
  1. Carrier is driven
  2. Ring gear is held
  3. Sun gear drives
- E. Reverse (speed increase)
  1. Sun gear is driven
  2. Carrier is held
  3. Ring gear drives

INFORMATION SHEET

F. Reverse (speed reduction)

   1. Ring gear is driven

   2. Carrier is held

   3. Sun gear drives

G. Direct drive--Any two of the units are locked together

XXIII. Planetary gear set controls and components used in automatic transmissions (Transparency 13)

A. Brake band

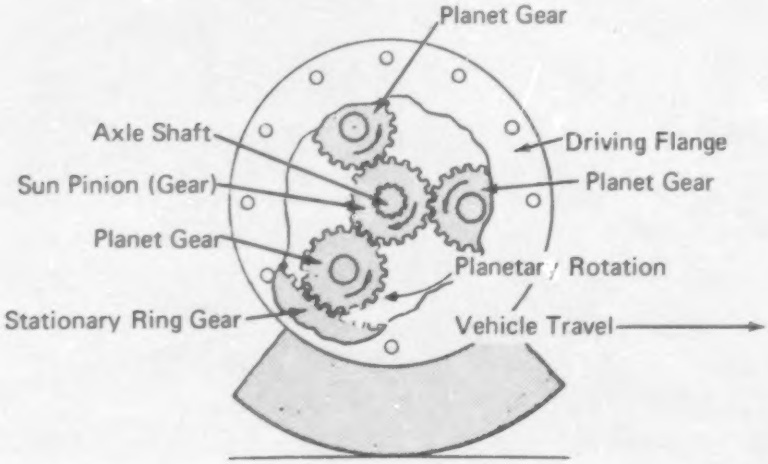
(NOTE: Bands are used to keep a component from turning by locking it to a case support.)

B. Clutch

(NOTE: Clutches are used to lock two components together to produce direct drive.)

XXIV. Components of a sun gear set found in a differential

(NOTE: A differential is essential for delivering power to the axles, which may have to revolve at different speeds. It is also used to steer macnines and change gear ratios by proper application of brakes.)


Planet Gear
Axle Shaft
Driving Flange
Sun Pinion (Gear)
Planet Gear
Planet Gear
Planetary Rotation
Stationary Ring Gear
Vehicle Travel

Used with permission of Euclid, Inc., a subsidiary of Daimler-Benz

INFORMATION SHEET

XXV. How reduction in speed and increase in torque is accomplished

A. Power is supplied to the axle

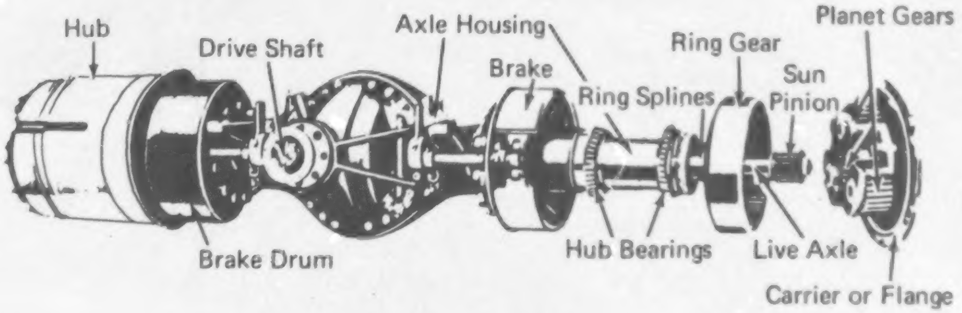
B. Work is performed by members attached to or driven by the flange

C. Turning of the sun gear causes planets to rotate

D. Rotation forces planets to "walk" around the tooth track formed by the ring gear, pulling the carrier or spider around with them in the same direction the axle rotates

XXVI. Components of an axle housing and final drive

(NOTE: A planetary gear set with fixed ring provides a compact and sturdy means of multiplying shaft torque. If the ring and spider can be either held or allowed to rotate, brake and clutch action can be obtained.)


Hub
Drive Shaft
Axle Housing
Brake
Ring Splines
Ring Gear
Sun Pinion
Planet Gears
Brake Drum
Hub Bearings
Live Axle
Carrier or Flange

Used with permission of Euclid, Inc., a subsidiary of Daimler-Benz

XXVII. Components of a propeller shaft (drive shaft) (Transparency 14)

A. Torsional damper

B. U-joint

C. Shaft

D. Center bearing support (carrier bearing)

E. Slip joint

F. Balance weight

INFORMATION SHEET

XXVIII. Types of U-joints (Transparency 15)

- A. Cross and roller
- B. Ball and trunnion
- C. Rzeppa

  (NOTE: This type of U-joint is used mainly on front-wheel drives.)

- D. Constant velocity

XXIX. Major components of a four-wheel drive vehicle (Transparency 16)

- A. Front propeller shaft
- B. Transfer case
- C. Rear propeller shaft

  (NOTE: On some vehicles an additional propeller shaft may be located between the transmission and transfer case.)

XXX. Purposes of torque converters

- A. Acts as a fluid coupling to connect engine power through oil to the transmission gear train
- B. Multiplies torque from the engine when additional performance is desired
- C. Acts as a flywheel for the engine

XXXI. Basic components of a torque converter and their purposes (Transparency 17)

- A. Impeller--Driving member of converter which drives transmission oil pump and encloses rear of converter
- B. Turbine--Is splined to and drives transmission input shaft; set in motion by fluid from impeller vanes
- C. Stator--Stationary set of vanes in converter used to cause torque multiplication
- D. Converter cover--Encloses converter at engine (front) end; connected to engine drive plate

  (NOTE: Within the torque converter there are various thrust washers which allow members to turn against one another.)

INFORMATION SHEET

XXXII. Purposes of stator

A. Changes fluid flow from opposing direction to helping direction when speed difference between turbine and impeller is high

B. Moves with fluid flow when there is little or no speed difference between turbine and impeller

XXXIII. Principles of torque multiplication (Transparencies 18 and 19)

A. Curved vanes allow fluid to change direction gradually

B. Curved impeller vanes throw fluid forward into turbine vanes

C. Fluid leaving turbine vanes strikes impeller vanes at 90° and opposes driving force of impeller

D. Torque is lost due to bounce-back effect

(NOTE: Bounce back is converted into usable energy by the stator.)

E. Stator with sharply curved vanes is positioned between trailing edge of turbine vanes and leading edge of impeller vanes

F. Direction of fluid is changed by the stator so that the force of the fluid strikes the impeller blades and then is directed into turbine so that any remaining energy is exerted on the turbine thus multiplying torque

XXXIV. Causes of overheating in a torque converter

(NOTE: Overheating is a major problem in torque converters. Its frequency and extent is affected by design, type of work, operator, air temperature, and condition of unit. Fluid must be checked frequently.)

A. Air in fluid system

B. Low basic fluid pressure

C. Insufficient cooling

D. Operating in high temperatures

E. Operating at high altitudes

F. Overloading

G. Defective temperature gage

H. Overspeeding

I. Transmission gear-selection incorrect for load

INFORMATION SHEET

XXXV. Characteristics of hydraulics

- A. Liquids have no shape of their own
- B. Liquids will not compress
- C. Liquids transmit applied pressure in all direcitons
- D. Liquids provide great increases in work force
- E. Liquids in a confined space can be used to transmit force

XXXVI. Components of basic hydraulic system (Transparency 20)

- A. Reservoir

  (NOTE: Oil is stored in the reservoir.)

- B. Pump

  (NOTE: Pumps generate force in the system.)

- C. Check valves

  (NOTE: Check valves control pressure and flow.)

- D. Cylinder

  (NOTE: Cylinder converts fluid movement to mechanical energy.)

- E. Spring

XXXVII. Types of hydraulic systems

- A. Hydrostatic

  (NOTE: The potential energy of a fluid under pressure is used to perform work.)

  Examples: Hydraulic press, hydraulic brakes

- B. Hydrodynamics

  (NOTE: The kinetic energy of a fluid in motion is used to perform work.)

  Example: Torque converter

XXXVIII. Functions of hydraulic system

- A. Provides a constant flow of hydraulic fluid under pressure to operate the system
- B. Provides cooling to dissipate heat

INFORMATION SHEET

C. Cleans and lubricates moving parts of the system

D. Applies pressure to the many pistons, control valves, and other moving parts

(NOTE: Pressure inside the system is measured in pounds per square inch [psi]. Changes in speed and force, equivalent to mechanical leverage advantages, are made by varying the relative areas of pistons and other movable parts.)

XXXIX. Types of hydraulic control valves (Transparency 21)

A. Check valves

(NOTE: The check valve is a simple but important device that allows passage of fluid in one direction only. Valve is held closed by a spring until pressure from opposite side compresses the spring so that fluid can flow past.)

B. Pressure relief valve

(NOTE: Relief valves are set for the pressure that the system should use, and spill any excess into a bypass back to the reservoir.)

C. Directional control

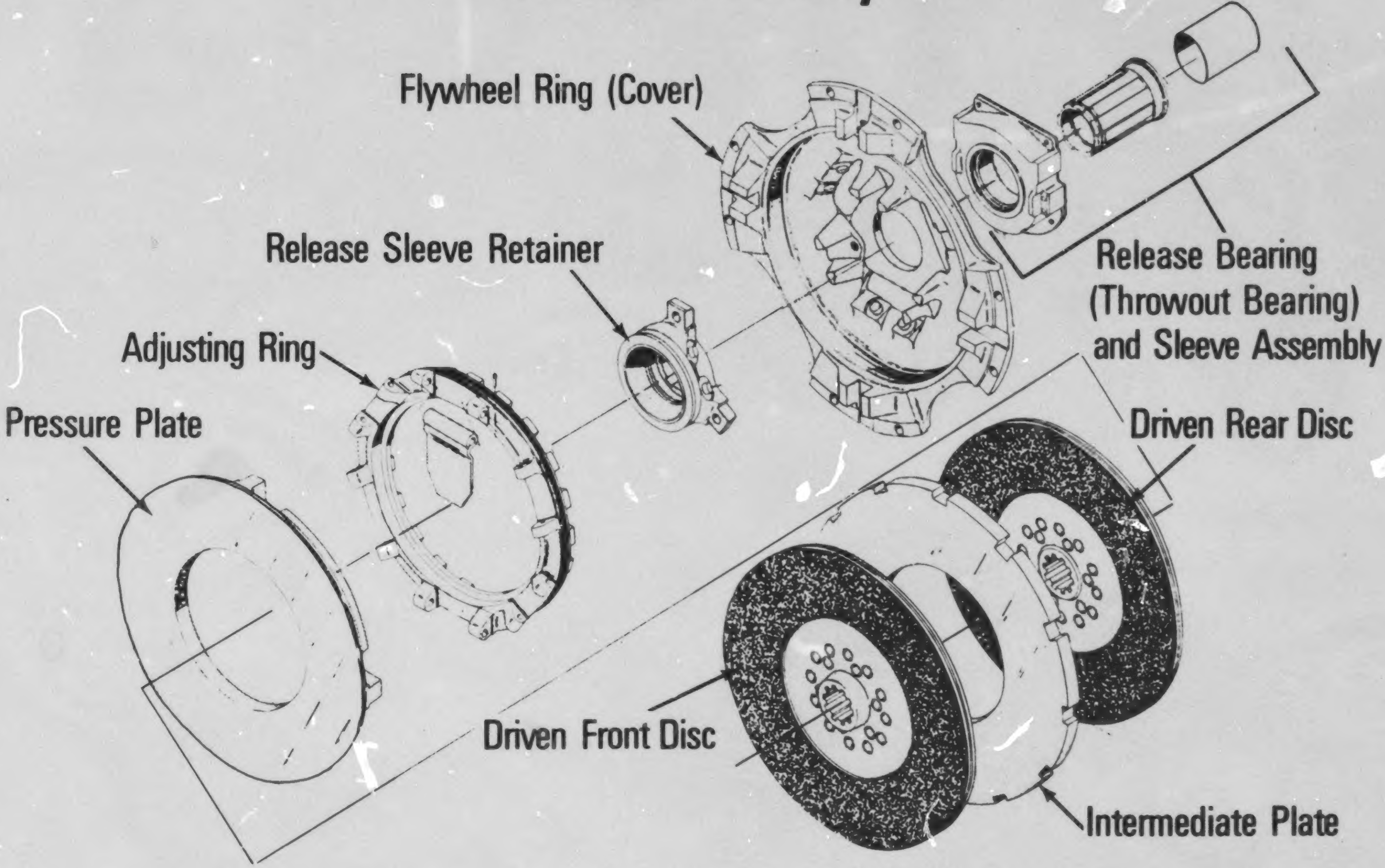
(NOTE: Directional control valve controls hydraulic fluid flow which activates a particular circuit to change the flow from one circuit to another when acted upon by manual force or by another hydraulic circuit.)

XL. Operation of balanced directional control valves (Transparency 22)

A. Mechanical--Produces changes in output fluid pressure proportional to the movement of mechanical linkages connected to one end of valve.

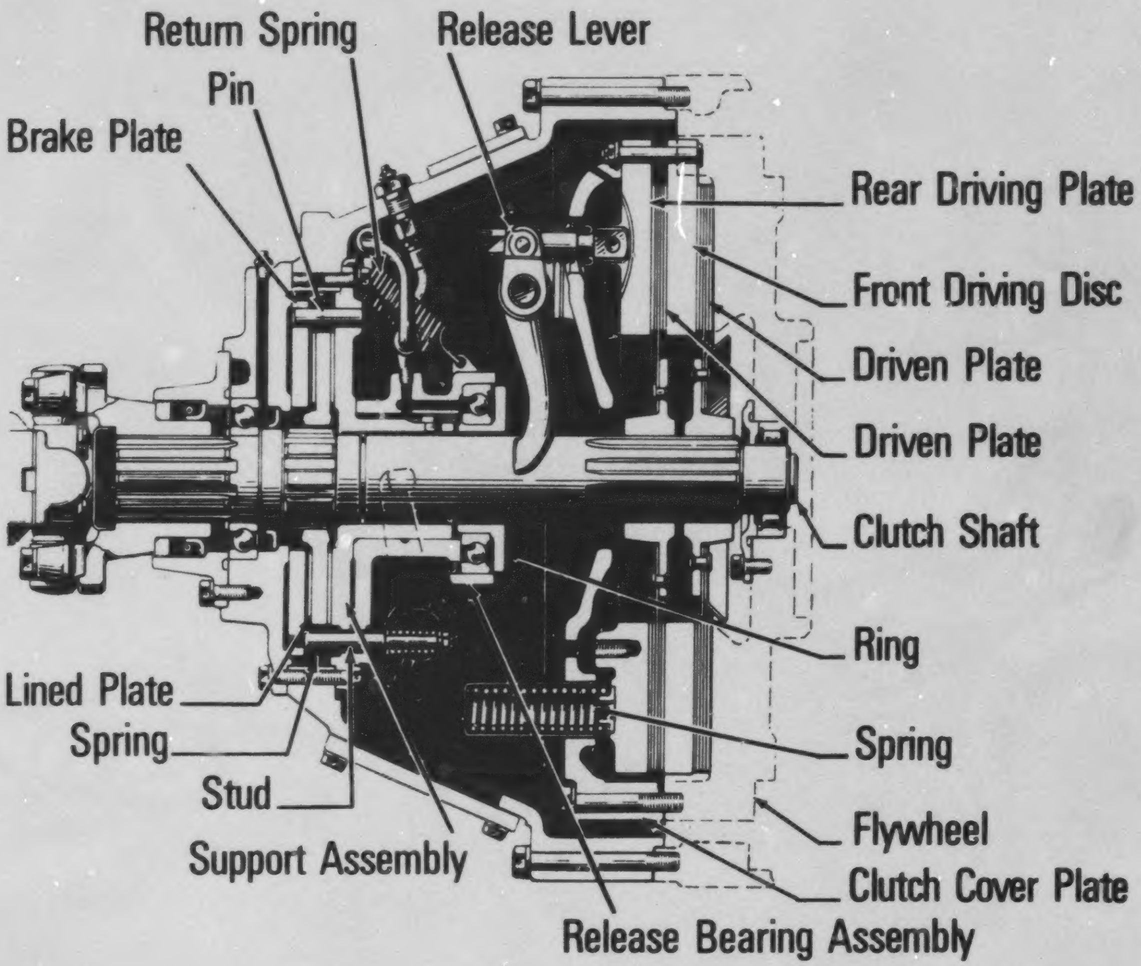
B. Hydraulic--Produces changes in output fluid pressure proportional to varying control fluid pressure which acts on one end of valve

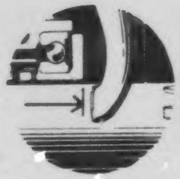
Clutch Assembly


Flywheel Ring (Cover)
Release Sleeve Retainer
Release Bearing
(Throwout Bearing)
and Sleeve Assembly
Adjusting Ring
Pressure Plate
Driven Rear Disc
Driven Front Disc
Intermediate Plate

Adapted from *Truck and Diesel Repair Manual*, Copyright 1980. Used with permission of Hearst Corporation.

Double Plate Clutch


Return Spring
Release Lever
Pin
Brake Plate
Rear Driving Plate
Front Driving Disc
Driven Plate
Driven Plate
Clutch Shaft
Ring
Spring
Flywheel
Clutch Cover Plate
Release Bearing Assembly
Support Assembly
Stud
Spring
Lined Plate



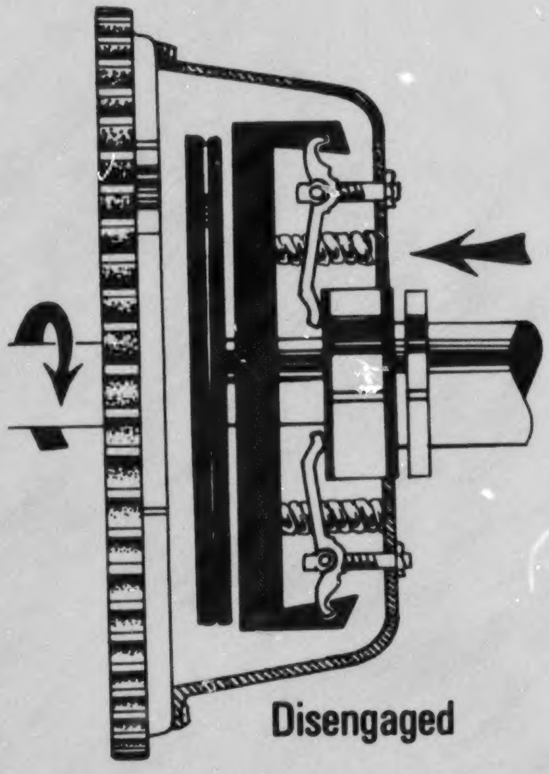
Note: Clearance between pressure plate fingers and release bearing should be 1/8" to 3/16"

Used with permission of Caterpillar Tractor Company.

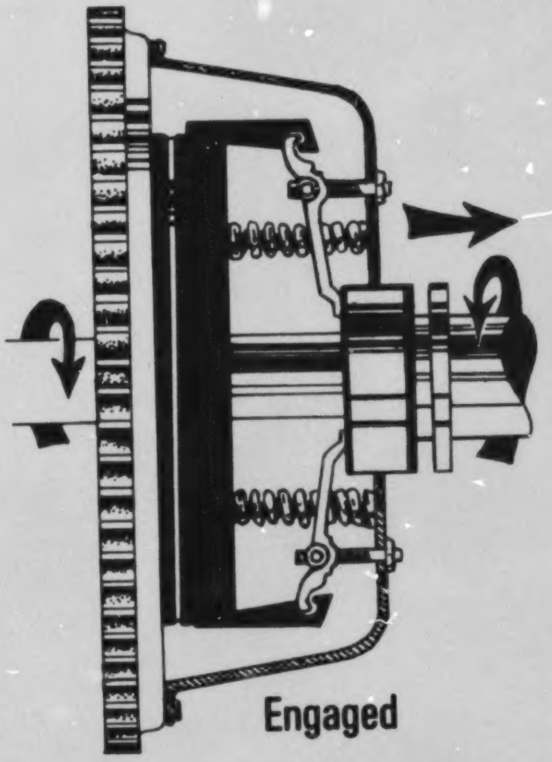
TM 2

HEO I - 177-D

Clutch Operation



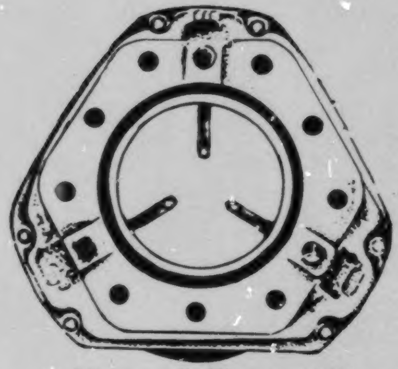
Disengaged



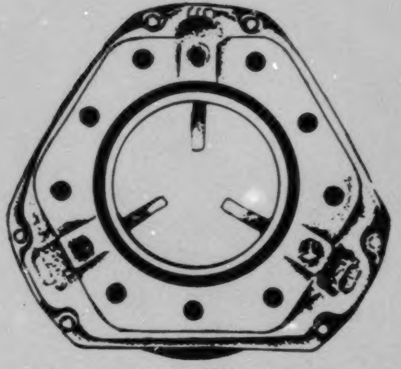
Engaged

676

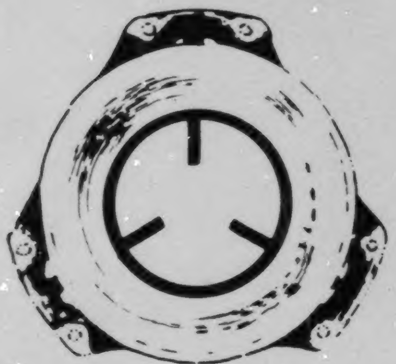
Clutch Inspection



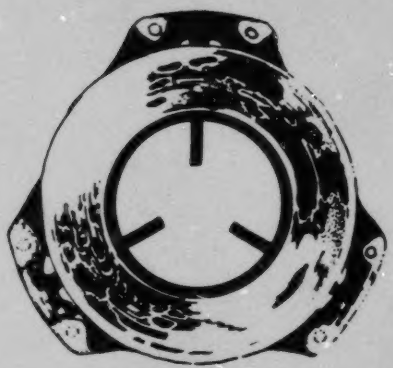
Normal Finger Wear



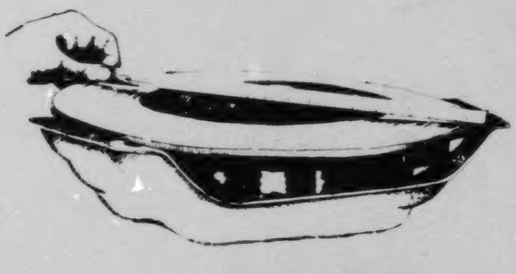
Excessive Finger Wear



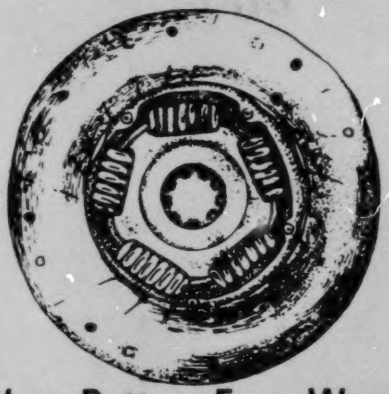
Chatter Marks



Excessive Heat Discoloration



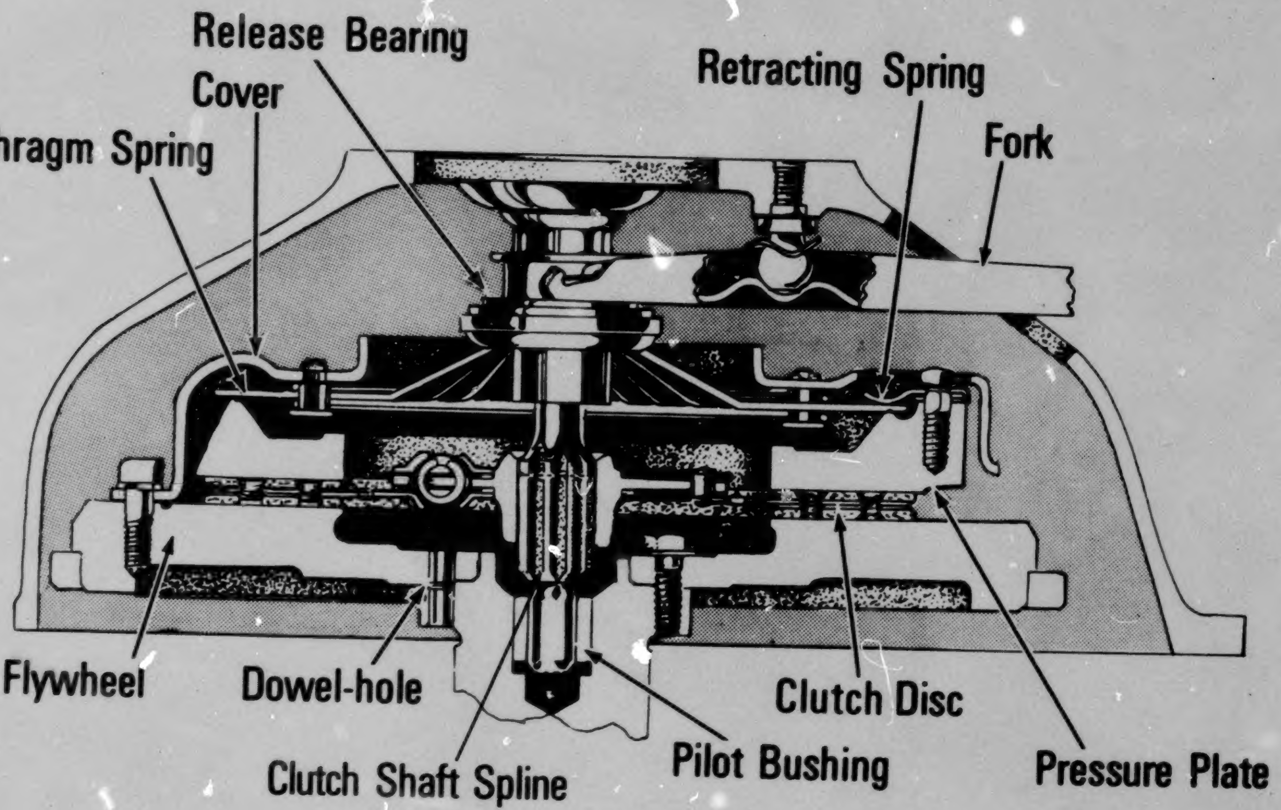
Excessive Warpage



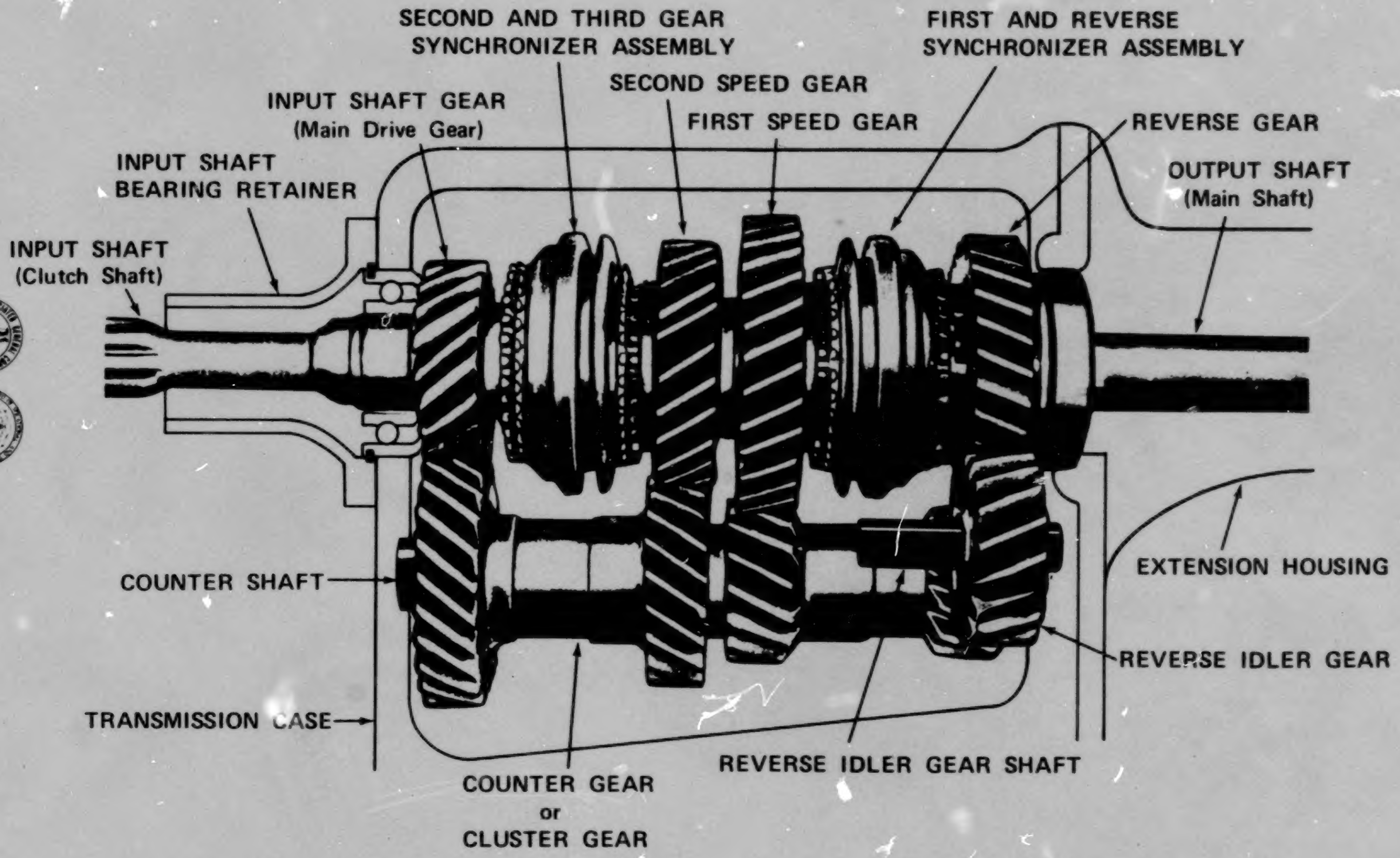
Wear Pattern From Warped Pressure Plate Or Flywheel

Clutch Inspection

(Continued)

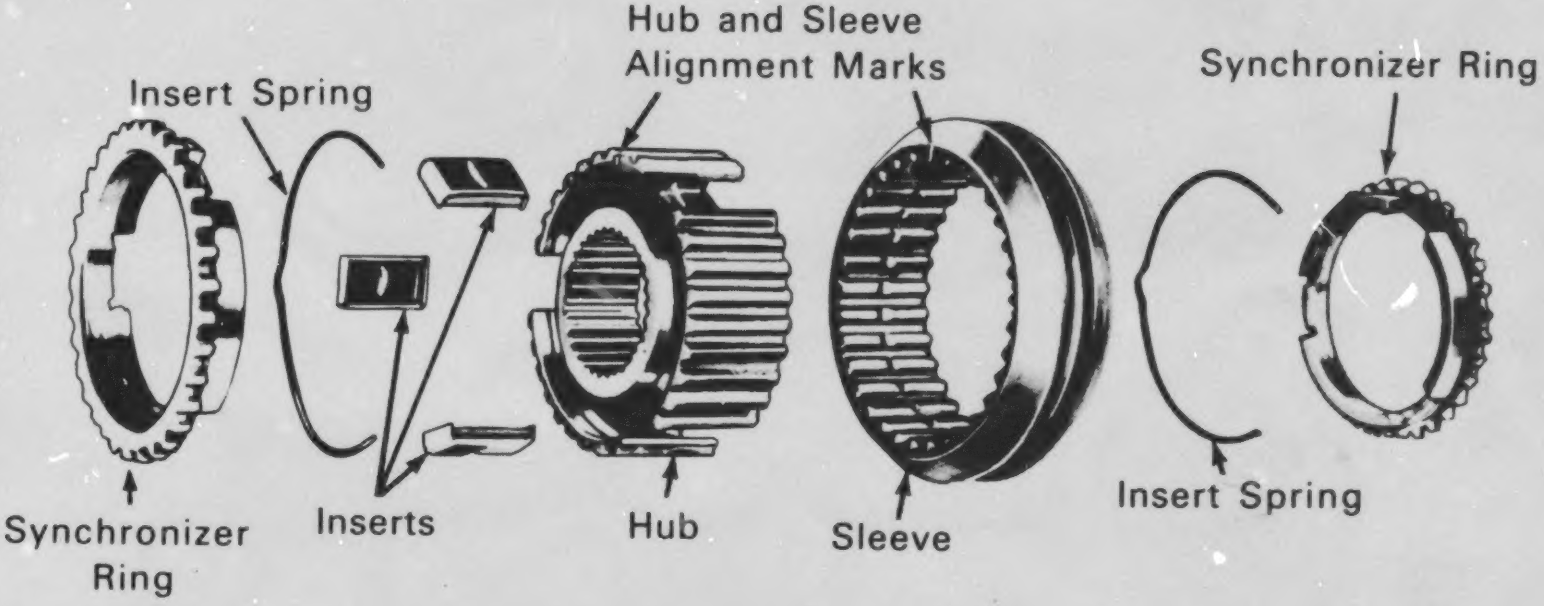

Release Bearing
Cover
Diaphragm Spring
Retracting Spring
Fork
Flywheel
Dowel-hole
Clutch Shaft Spline
Pilot Bushing
Clutch Disc
Pressure Plate

Parts of the Transmission


SECOND AND THIRD GEAR SYNCHRONIZER ASSEMBLY
FIRST AND REVERSE SYNCHRONIZER ASSEMBLY
SECOND SPEED GEAR
INPUT SHAFT GEAR (Main Drive Gear)
FIRST SPEED GEAR
REVERSE GEAR
INPUT SHAFT BEARING RETAINER
OUTPUT SHAFT (Main Shaft)
INPUT SHAFT (Clutch Shaft)
COUNTER SHAFT
EXTENSION HOUSING
REVERSE IDLER GEAR
TRANSMISSION CASE
REVERSE IDLER GEAR SHAFT
COUNTER GEAR or CLUSTER GEAR

HEO I - 185-D

Parts of a Typical Synchronizer


Insert Spring
Hub and Sleeve Alignment Marks
Synchronizer Ring
Synchronizer Ring
Inserts
Hub
Sleeve
Insert Spring

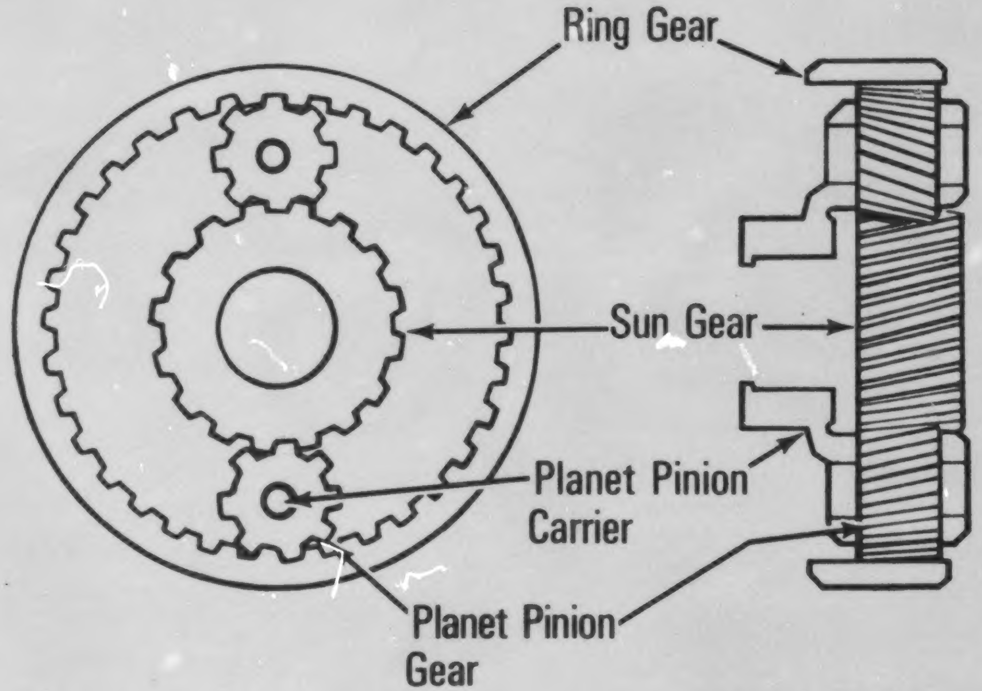
TM 7

682

683

HEO I - 187-D

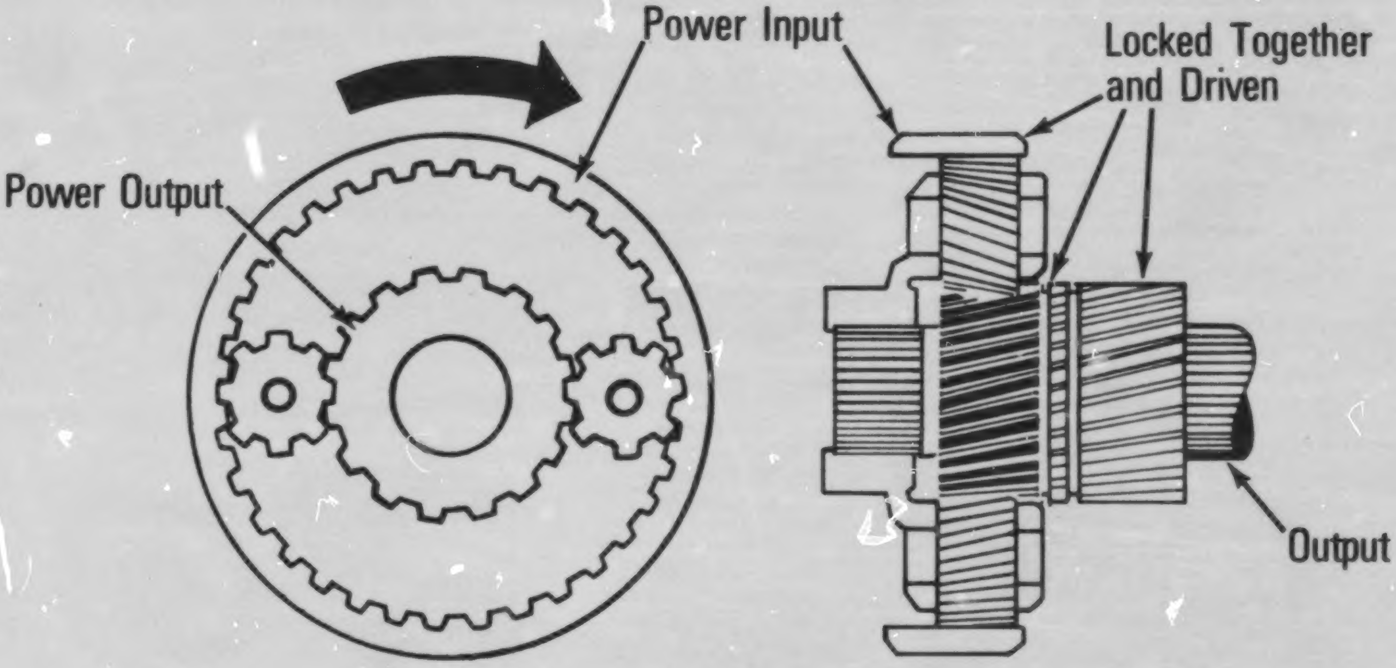
Planetary Gear Set Components


Ring Gear
Sun Gear
Planet Pinion Carrier
Planet Pinion Gear

TM 8

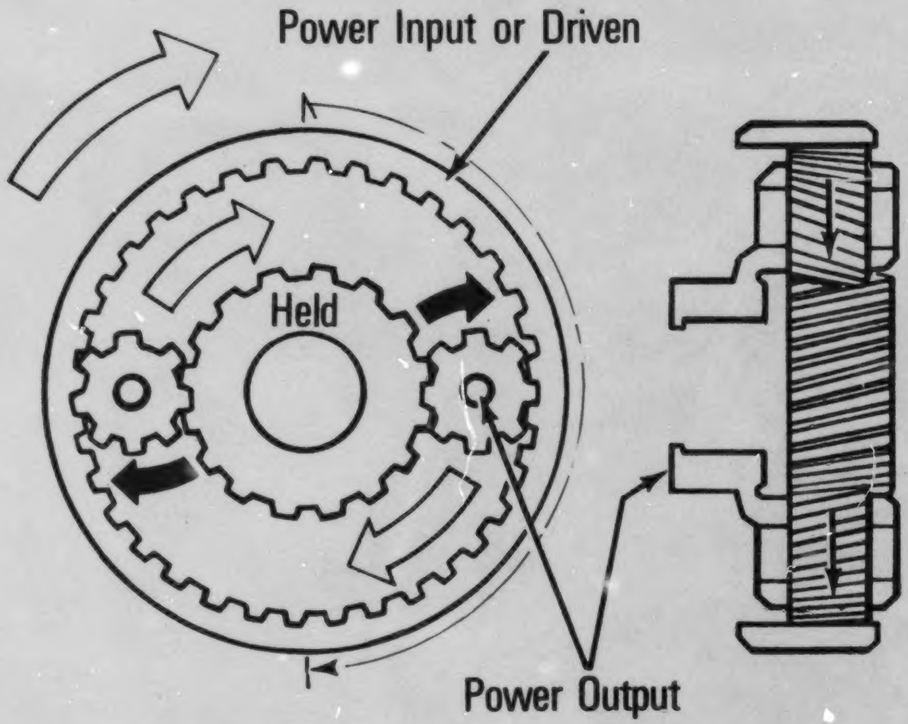
HEO I - 189-D

Direct Drive Mode

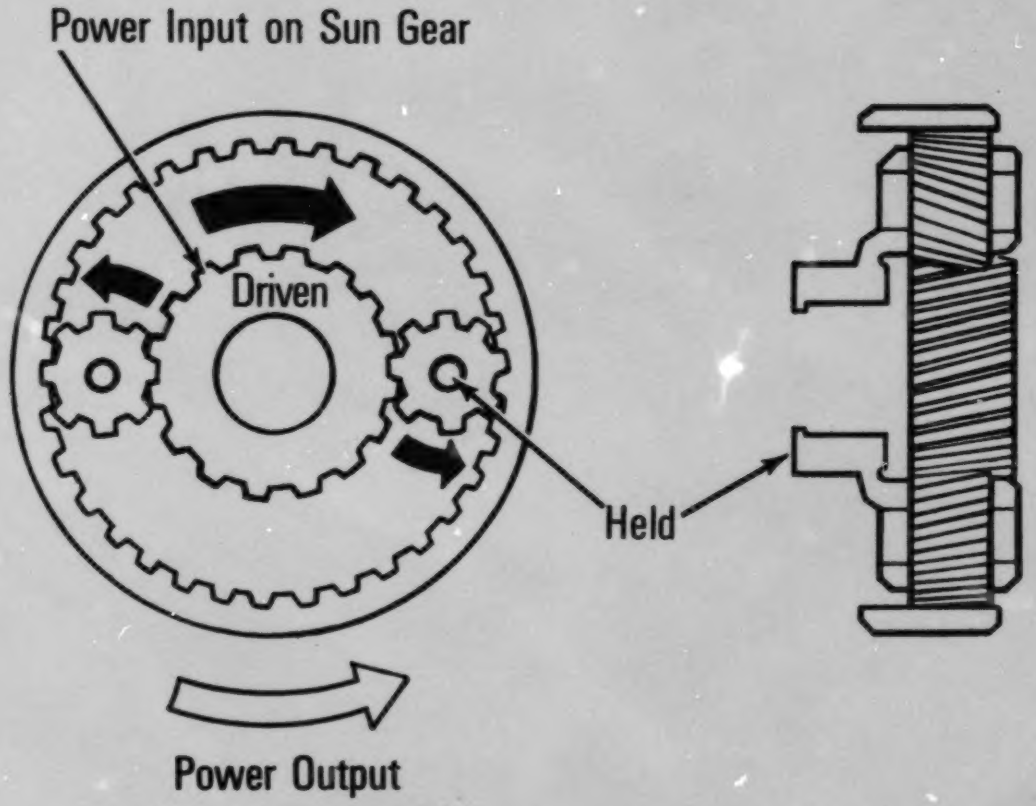

Power Input
Locked Together and Driven
Power Output
Output

(Note: When any Two Components of a Planetary Gear Set Are Locked Together, Input and Output Operate at a 1:1 Ratio)

Speed Reduction Mode


Power Input or Driven
Held
Power Output

Reverse Gear Mode


Power Input on Sun Gear
Driven
Held
Power Output

Operating Conditions and Results of a Planetary Gear Set

CONDITION	1	2	3	4	5	6
Ring Gear	D	H	T	H	T	D
Carrier	T	T	D	D	H	H
Sun Gear	H	D	H	T	D	T
Speed	I	I	L	L	IR	LR

D-Driven
H-Hold
I-Increase of Speed

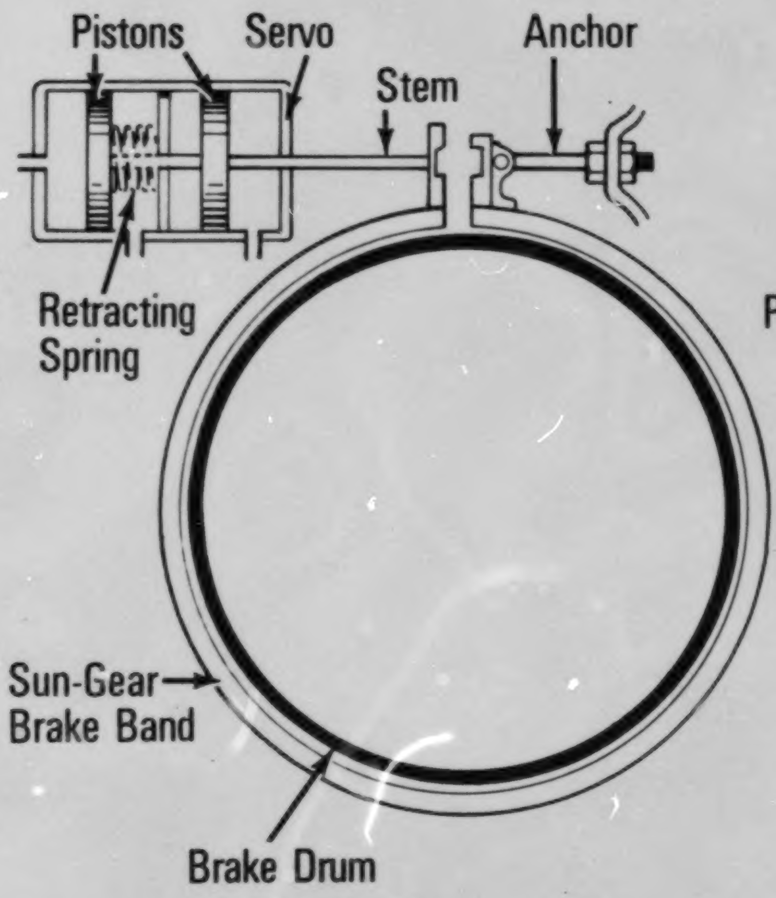
L-Reduction of Speed
R-Reverse
T-Turn or Drive

TM 12

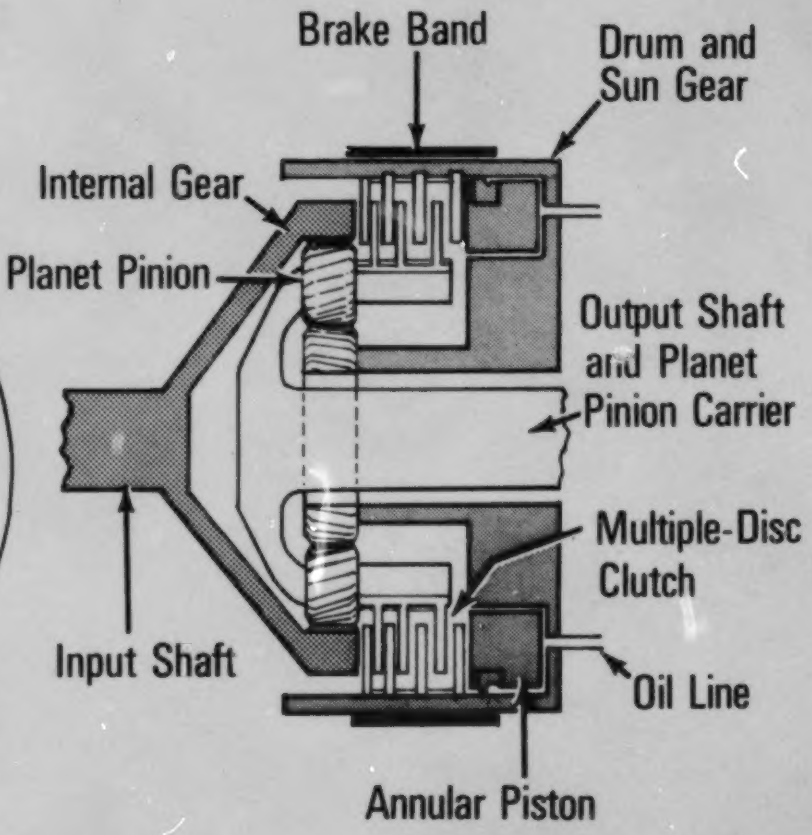
HEO I - 197-D

Brake Band and Clutch

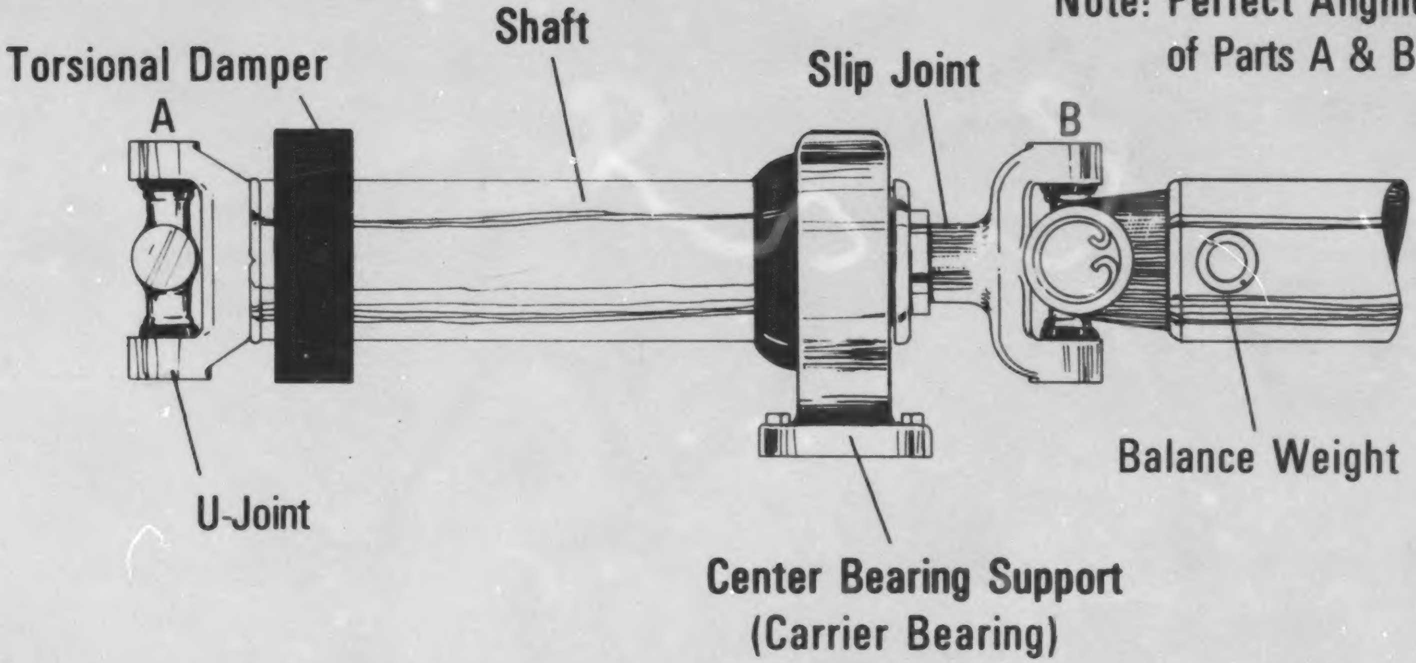
Band


Pistons
Servo
Stem
Anchor
Retracting Spring
Sun-Gear Brake Band
Brake Drum

Clutch

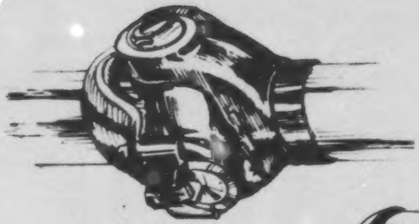

Brake Band
Drum and Sun Gear
Internal Gear
Planet Pinion
Output Shaft and Planet Pinion Carrier
Multiple-Disc Clutch
Input Shaft
Oil Line
Annular Piston

Propeller Shaft Components

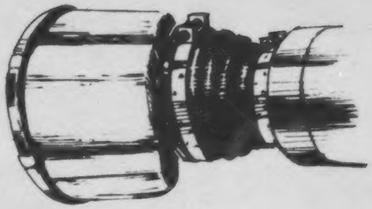

Shaft
Torsional Damper
A
Slip Joint
B
U-Joint
Balance Weight
Center Bearing Support
(Carrier Bearing)

Note: Perfect Aligment
of Parts A & B

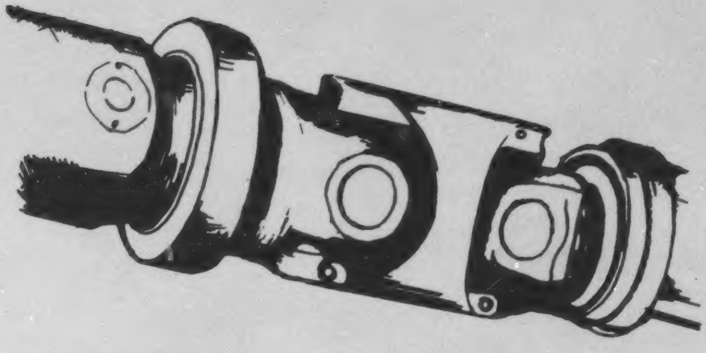
Types of U-Joints



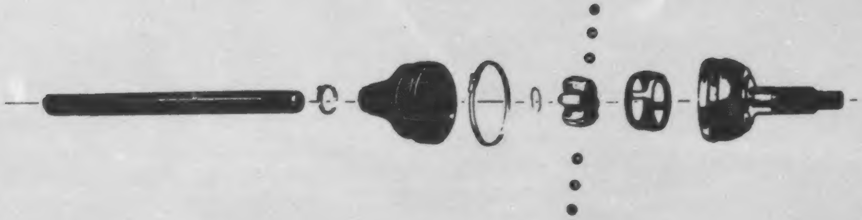
Cross and Roller



Ball and Trunnion

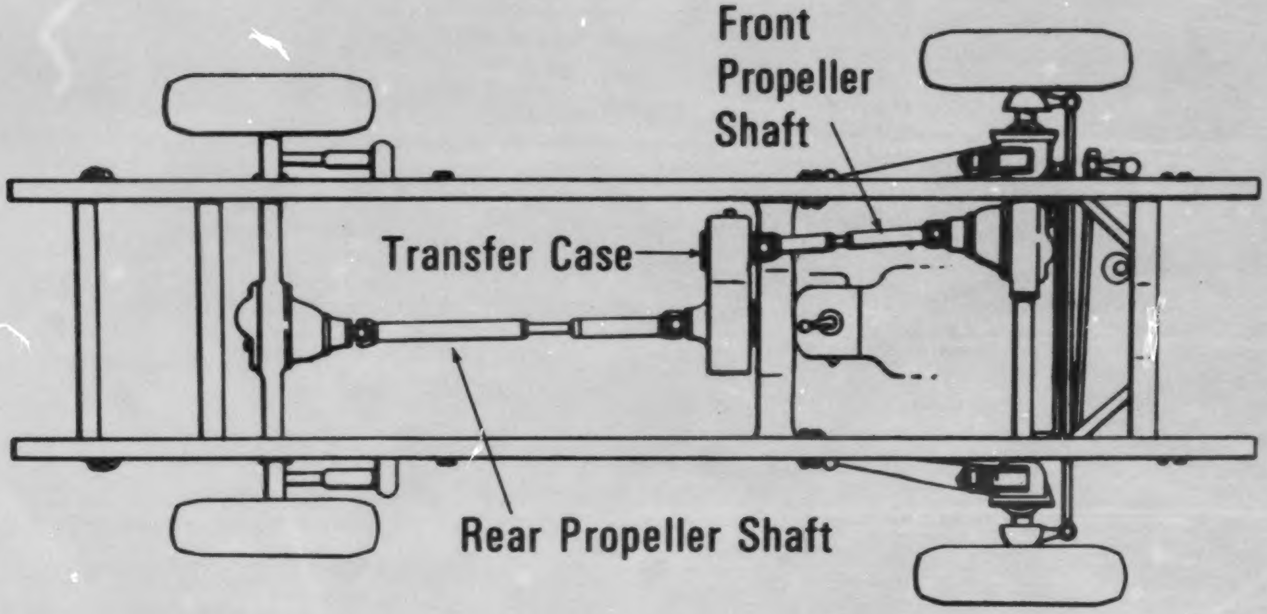


Constant Velocity



Rzeppa

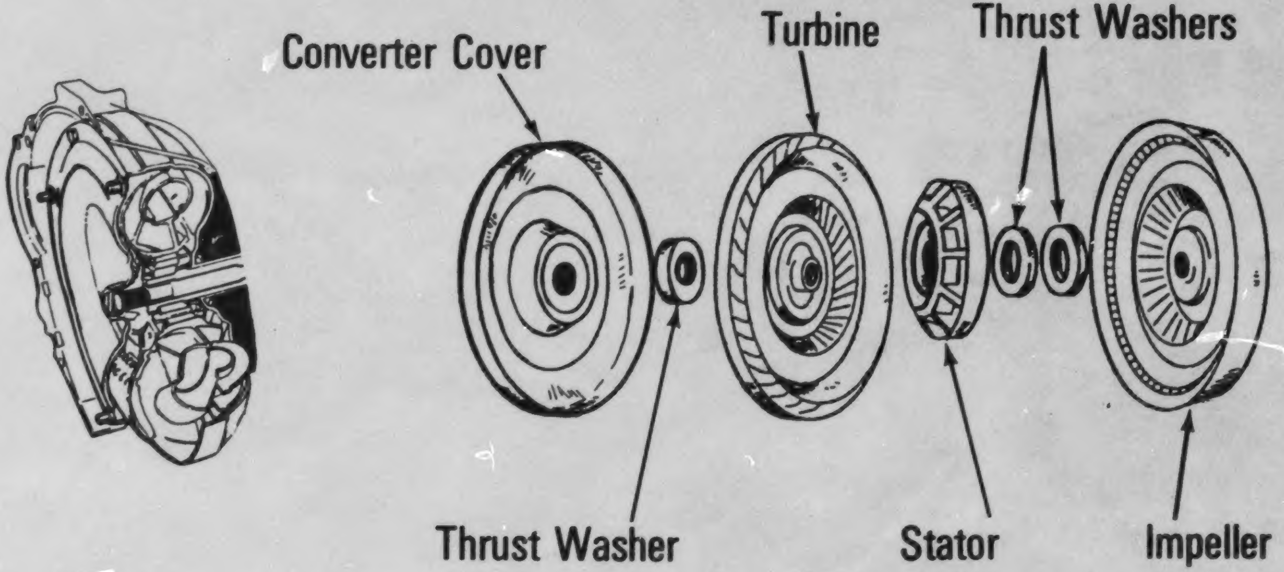
Components of the Drive Train on a Four-Wheel Drive Vehicle


Front Propeller Shaft
Transfer Case
Rear Propeller Shaft

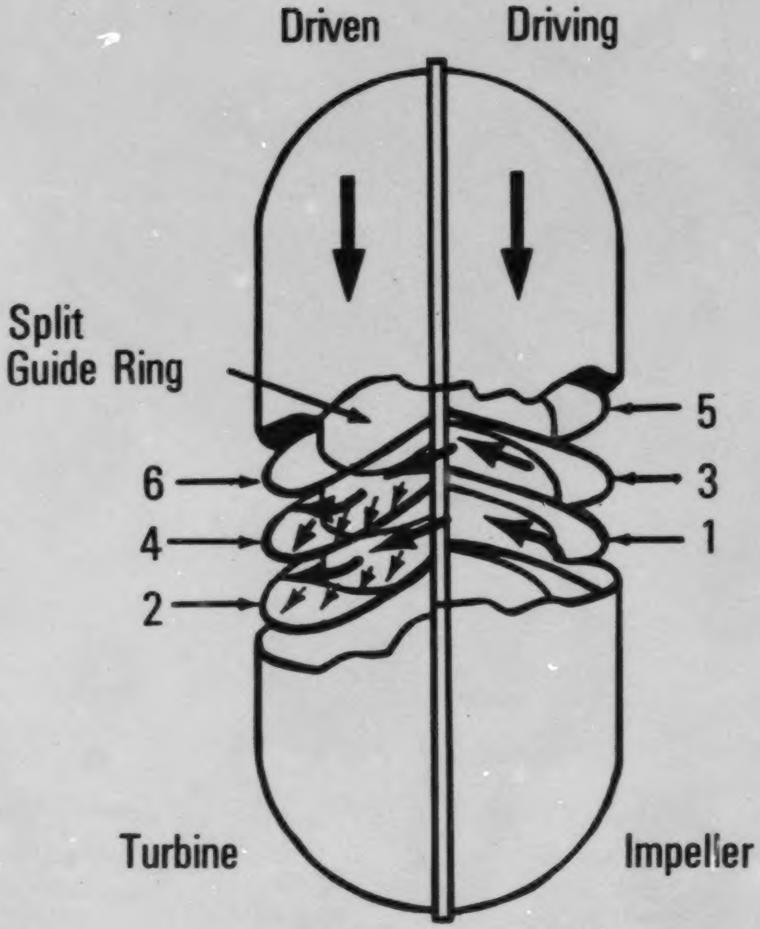
TM 16

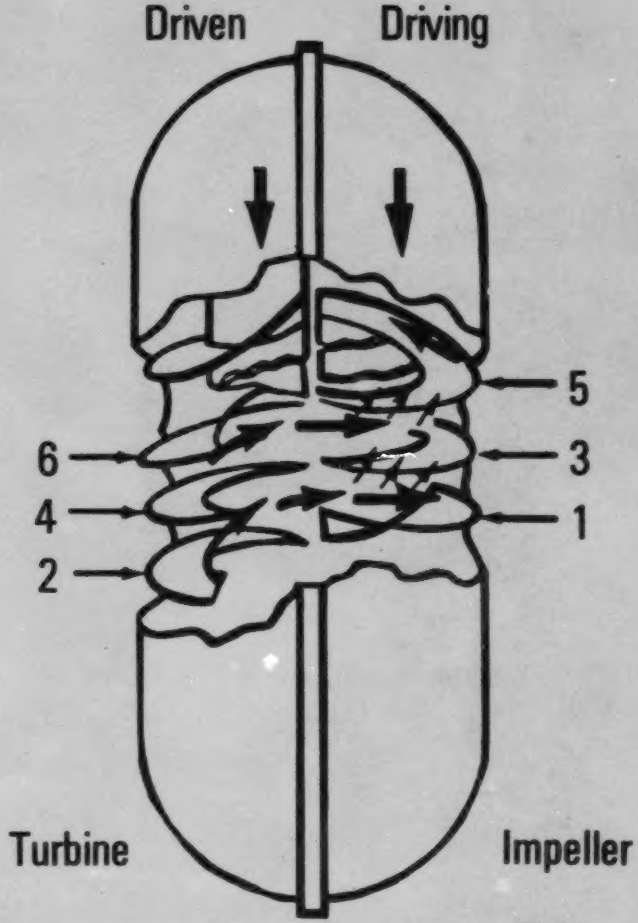
HEO I - 205-D

Torque Converter Construction


Converter Cover
Turbine
Thrust Washers
Thrust Washer
Stator
Impeller

Torque Multiplication


Driven
Driving
Split Guide Ring
5
6
3
4
1
2
Turbine
Impeller


Driven
Driving
5
6
3
4
1
2
Turbine
Impeller

TM 18

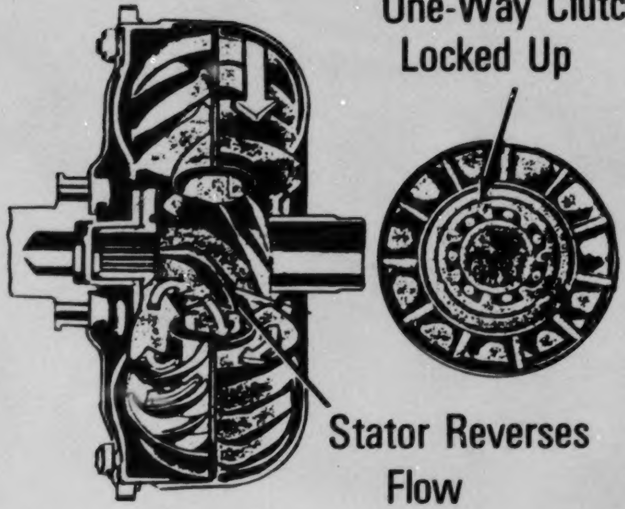
704

705

HEO I - 209-D

Torque Multiplication

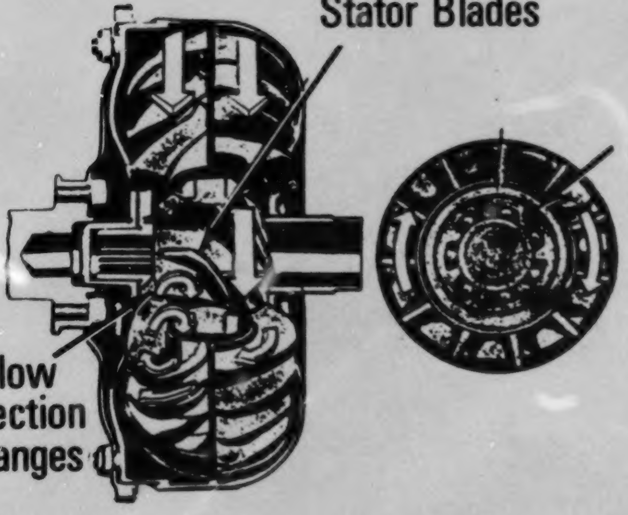
(Continued)



One-Way Clutch Locked Up

Stator Reverses Flow

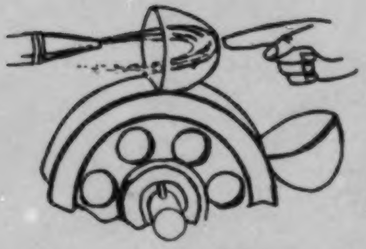
3 Units Turn Together

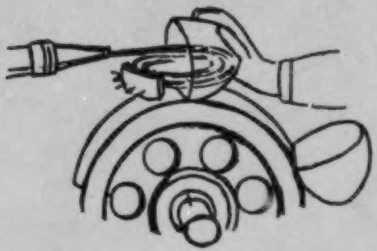


Back of Stator Blades

One-Way Clutch Unlocked

Flow Direction Changes





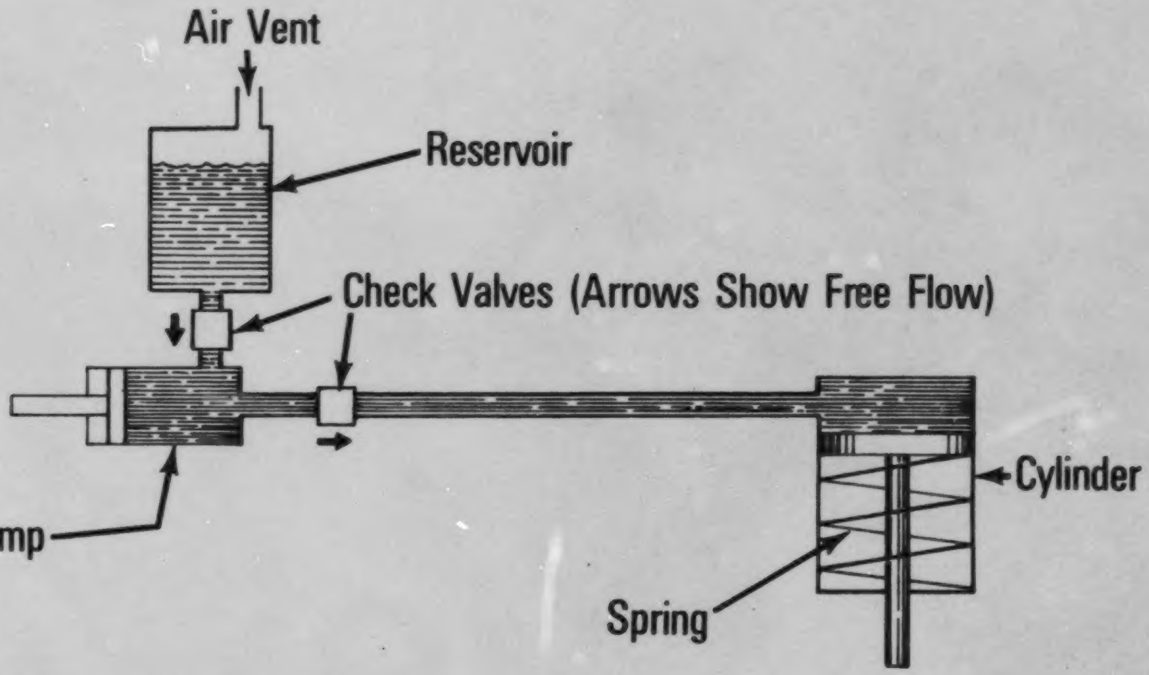
706

707

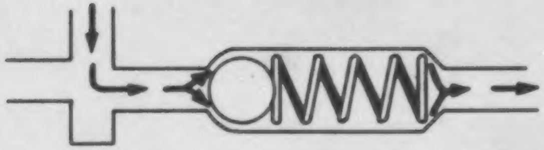
TM 19

HEO I-211-D

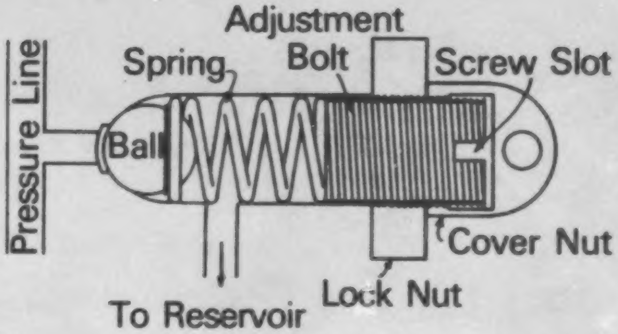
Basic Hydraulic System


Air Vent
Reservoir
Check Valves (Arrows Show Free Flow)
Pump
Cylinder
Spring

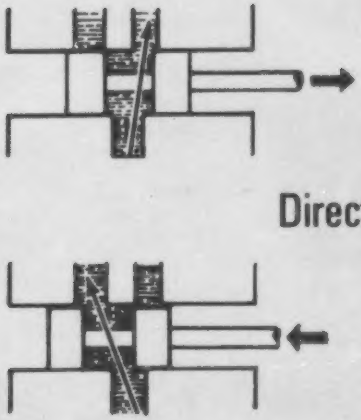
Types of Valves



Check Valve


Adjustment Bolt
Spring
Screw Slot
Pressure Line
Ball
Cover Nut
Lock Nut
To Reservoir

Pressure Relief Valve

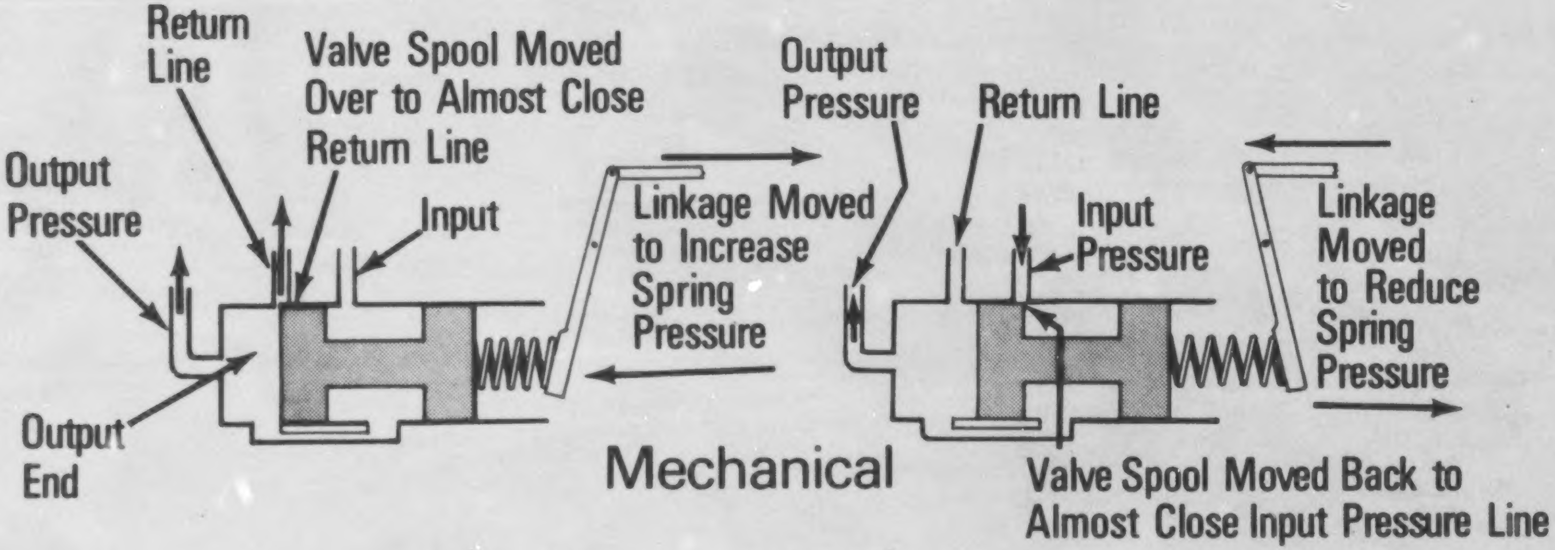


Directional Control

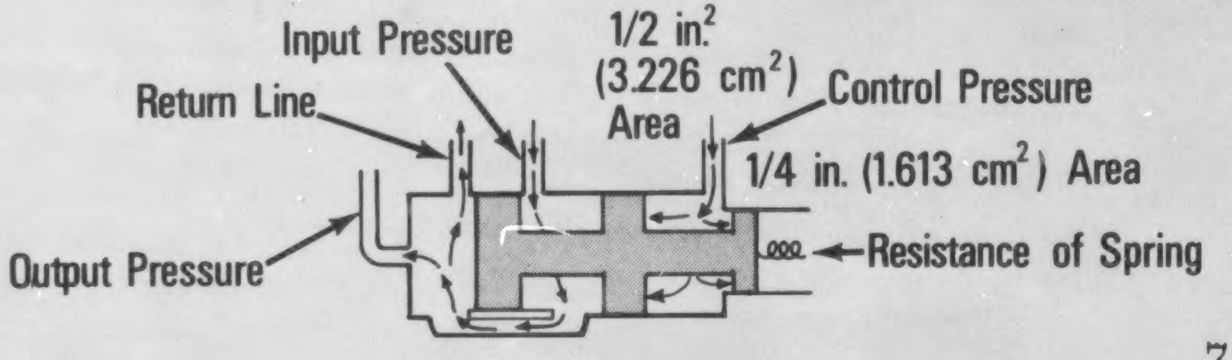
TM 21

HEO I - 215-D

Balanced Valve Operation


Return Line
Valve Spool Moved Over to Almost Close Return Line
Output Pressure
Input
Linkage Moved to Increase Spring Pressure
Output End
Output Pressure
Return Line
Input Pressure
Linkage Moved to Reduce Spring Pressure
Valve Spool Moved Back to Almost Close Input Pressure Line

Mechanical


Input Pressure
1/2 in.^{2} (3.226 cm^2) Area
Return Line
Control Pressure
1/4 in. (1.613 cm^2) Area
Resistance of Spring
Output Pressure

Hydraulic

DRIVE TRAIN
UNIT II

JOB SHEET #1--ADJUST CLUTCH LINKAGE FREE TRAVEL

I. Tools and equipment

A. Basic hand tool set

B. Floor jack

C. Jack stands, 4

D. Drop light

E. Creeper

F. Safety glasses

II. Procedure

A. Make sure clutch pedal or lever returns firmly against bumper when released

B. Locate adjustment on clutch linkage

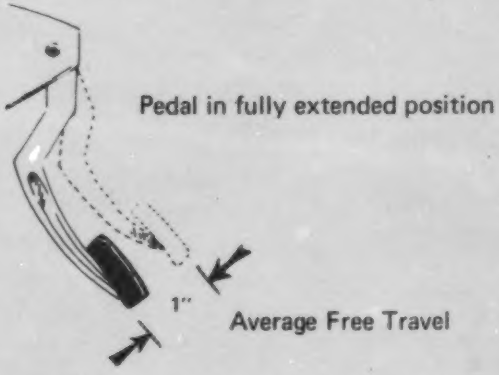
C. Check clutch linkage for binding

D. Adjust clutch linkage

E. Adjust linkage until desired free travel is obtained (Figure 1)

(NOTE: Adjust linkage to manufacturer's specifications. Usually, about one inch of clutch pedal free travel is desired. When adjusting linkage, actually you are setting clearance between pressure plate fingers and release bearing. See inset in TM 2.)

FIGURE 1



ADJUST CLUTCH FREE TRAVEL

JOB SHEET #1

F. Secure locknut on adjuster if so equipped

(NOTE: Generally the hydraulic clutch is adjusted on the linkage between the slave cylinder and release fork. This procedure is also used on the hydraulic clutch.)

DRIVE TRAIN
UNIT II

JOB SHEET #2--SHIFT A POWER SHIFT TRANSMISSION

I. Equipment--Bulldozer with power shift transmission

II. Procedure

A. Mount bulldozer using steps and grab irons

B. Sit down in operator's seat

C. Secure safety belts

D. Turn master switch to "on" and start tractor engine

E. Raise lowered equipment 15 inches off ground

F. Depress brake pedals to release brakes

G. Release transmission safety lock

H. Move governor control lever to full throttle

I. Depress decelerator pedal to slow engine speed

J. Select desired direction and gear

K. Release decelerator pedal and allow bulldozer to move forward to full speed

L. Downshift transmission on the move without decelerating engine

Examples: 3rd to 2nd and 2nd to 1st

M. Decrease engine speed to idle by depressing decelerator pedal

N. Move transmission selector to the opposite direction

O. Slowly release decelerator pedal to full engine speed

P. Downshift to low gear, and at the same time depress decelerator pedal to allow bulldozer to stop

Q. Select neutral transmission

R. Apply transmission lock

S. Apply parking brake

T. Push governor to "closed" position to shut down engine

U. Turn master switch off and remove key

V. Dismount bulldozer using steps and grab irons

DRIVE TRAIN
UNIT II

TEST

NAME ______________________________ SCORE __________

1. Match terms associated with drive train to the correct definitions. Write the correct numbers in the blanks provided.

_____a. System connecting engine to drive wheels; transfers power from power source to wheels and/or tracks

_____b. Plate which provides friction between pressure plate and flywheel

_____c. Housing, spring, and plate assembly which provide pressure to clamp clutch disc between pressure plate and flywheel

_____d. Bearing which provides a method of releasing the pressure plate spring pressure

_____e. Y-shaped lever inside clutch housing used to engage and disengage clutch

_____f. Heavy metal disc which has a friction surface for clutch plate, and supports all clutch components

_____g. Any series of rods, pedals, or levers used to transmit motion from one unit to another

_____h. Amount of clutch pedal movement before release bearing contacts pressure plate fingers

_____i. Lever assembly giving mechanical advantage to pressure plate springs to release clutch plate

_____j. Engaging and disengaging clutch while in neutral to slow down jackshaft for smooth engagement of gears

_____k. Shaft connecting transmission to differential

_____l. Unit that drives both rear wheels at the same time but allows them to turn at different speeds when making turns

1. Release fork
2. Pressure plate
3. Pressure plate fingers
4. Propeller shaft (drive shaft)
5. Flywheel
6. Free travel
7. Drive train
8. Differential
9. Release bearing (throwout bearing)
10. Power shift
11. Linkage
12. Clutch disc

_____m. Transmission that can be shifted while transmitting full engine power to axles

_____n. To adjust to a synchronized condition

_____o. "Y" or two-pronged connection on drive shaft

_____p. Inner and outer rings of U-joint bearings

_____q. Platform with roller-type feet; used to lie on while working overhead under equipment

_____r. Tool made from a short steel rod, sharpened on one end and used to make a mark on or small impression in metal

_____s. Thin, often tapered, piece of material used as a spacer to adjust or make slight corrections

_____t. The part of the hydraulic system in which pressure is generated

_____u. A cylinder which is controlled by or through another unit of the same type

_____v. Slot or groove cut in a shaft or bore

_____w. Turning or twisting force

_____x. Intermediate driving shaft

_____y. Either of two opposite pivots, or cylindrical projections, on each side of a part or assembly; used to provide a means of swiveling or turning the part or assembly

_____z. Split ring that is snapped into a groove in a shaft or hole; used to hold in place bearings, thrust washers, gears, and so on

_____aa. Assembly of gears whose organization resembles the solar system

_____bb. Smallest gear of a system

_____cc. Device that locates and carries the planet pinion gears

_____dd. Relationship between the number of turns make by a driving gear and one complete turn of the driven gear

_____ee. Gear shaped like a ring

_____ff. Center gear of planetary gear set that meshes with the planet pinion gear

13. Double clutching
14. Yoke
15. Center punch
16. Spline
17. Master cylinder
18. Snap ring
19. Cross bearing race
20. Shim
21. Torque
22. Phasing
23. Trunnion
24. Jackshaft
25. Slave cylinder
26. Creeper
27. Gear ratio
28. Sun gear
29. Planetary gear set
30. Ring gear
31. Pinion carrier
32. Pinion gear

2. List components of a drive train (power train).

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

3. Identify components of clutch assembly illustrated below. Write the correct names in the blanks provided.

Release bearing (throwout bearing) and sleeve assembly

Adjusting ring

Pressure plate

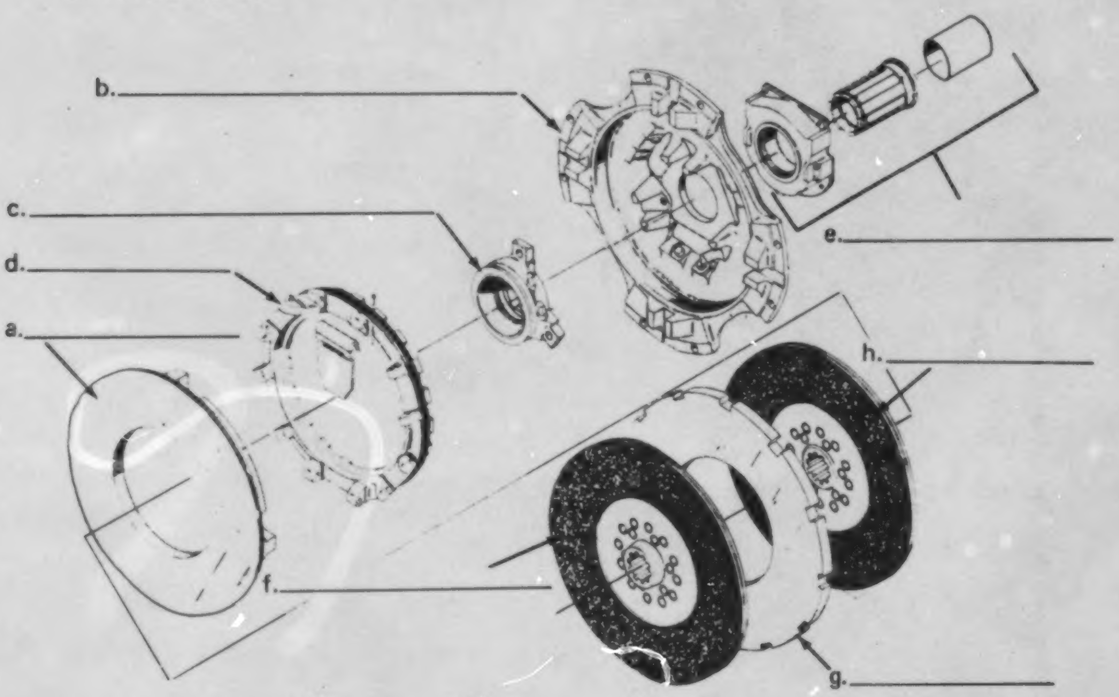
Intermediate plate

Driven rear disc

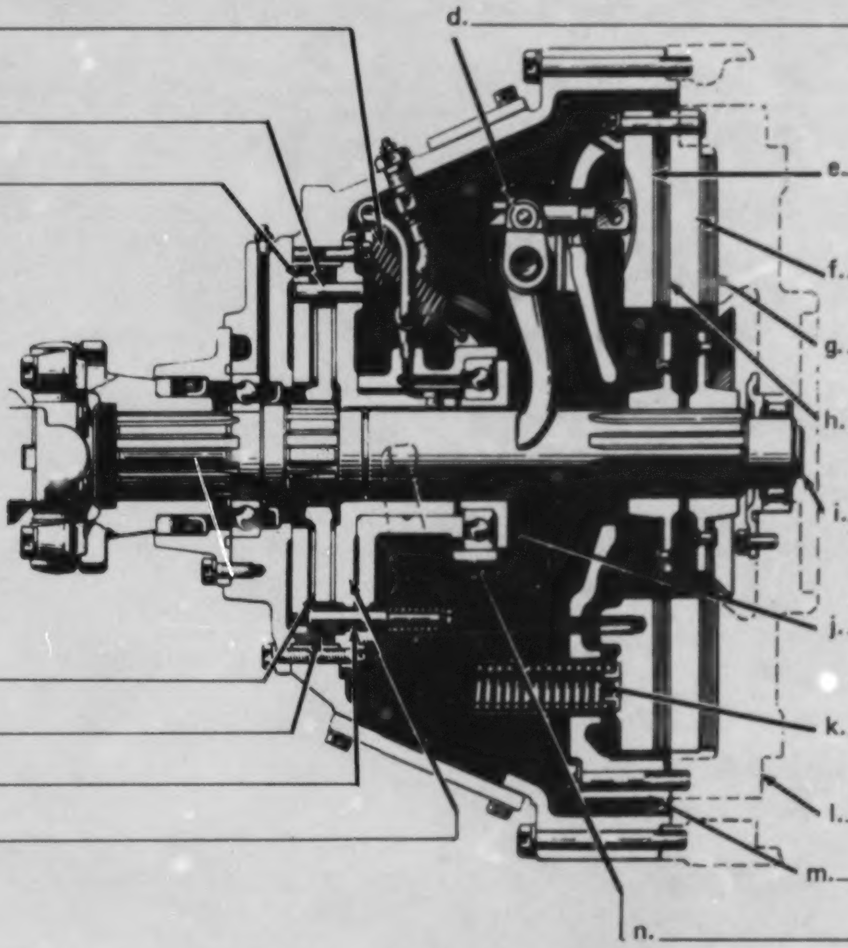
Driven front disc

Flywheel ring (cover)

Release sleeve retainer



4. Label parts of double plate clutch illustrated below. Write the correct names in the blanks provided.



a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

f. ____________________

g. ____________________

h. ____________________

i. ____________________

j. ____________________

k. ____________________

l. ____________________

m. ____________________

n. ____________________

o. ____________________

p. ____________________

q. ____________________

r. ____________________

5. Describe engaged and disengaged clutch operation.

   a. Engaged-- ____

   ____

   b. Disengaged-- ____

   ____

6. Distinguish difference between mechanical and hydraulic methods used to actuate clutch release.

   a. Mechanical

   ____

   ____

   b. Hydraulic

   ____

   ____

7. Match clutch malfunctions to probable causes. Write the correct number or numbers in the blanks provided. Answers may be used more than once, and a blank may have more than one correct answer.

______a. Pressure plate spring tension weak
______b. Pressure plate not releasing due to improper linkage adjustment
______c. Glazed clutch lining
______d. Uneven pressure plate finger height
______e. Improperly adjusted clutch linkage
______f. Warped pressure plate or flywheel
______g. Release bearing dragging on support
______h. Worn or dry pilot or release bearing when clutch is disengaged
______i. Oil contamination
______j. Weak pressure plate spring
______k. Broken pivots in pressure plate
______l. Water-contaminated clutch disc rusted to flywheel and pressure plate
______m. Broken motor mounts
______n. Excessively worn clutch disc

1. Grab
2. Binding
3. Pulsating pedal
4. Slip
5. Bearing noise
6. Drag
7. Freezing
8. Chatter

_____o. Worn or misaligned linkage

_____p. Pitted clutch shaft bearing when clutch is engaged with transmission in neutral

8. Select from the following list conditions to look for during clutch inspection. Mark each correct answer with an "X."

_____a. Loose nuts or bolts

_____b. Excessive warpage

_____c. Wear pattern from clutch disc

_____d. Discoloration from hot finger

_____e. Chatter marks

_____f. Worn clutch disc

_____g. Worn, notched, or hot pilot bearing

_____h. Loose or worn clutch disc hub

_____i. Worn pilot bearing

_____j. Too thick clutch disc

_____k. Weak pressure plate spring tension

_____l. Heat cracks

_____m. Worn clutch shaft spline

_____n. Fingers too tight

_____o. Too much fluid

9. Describe clutch brake.

____

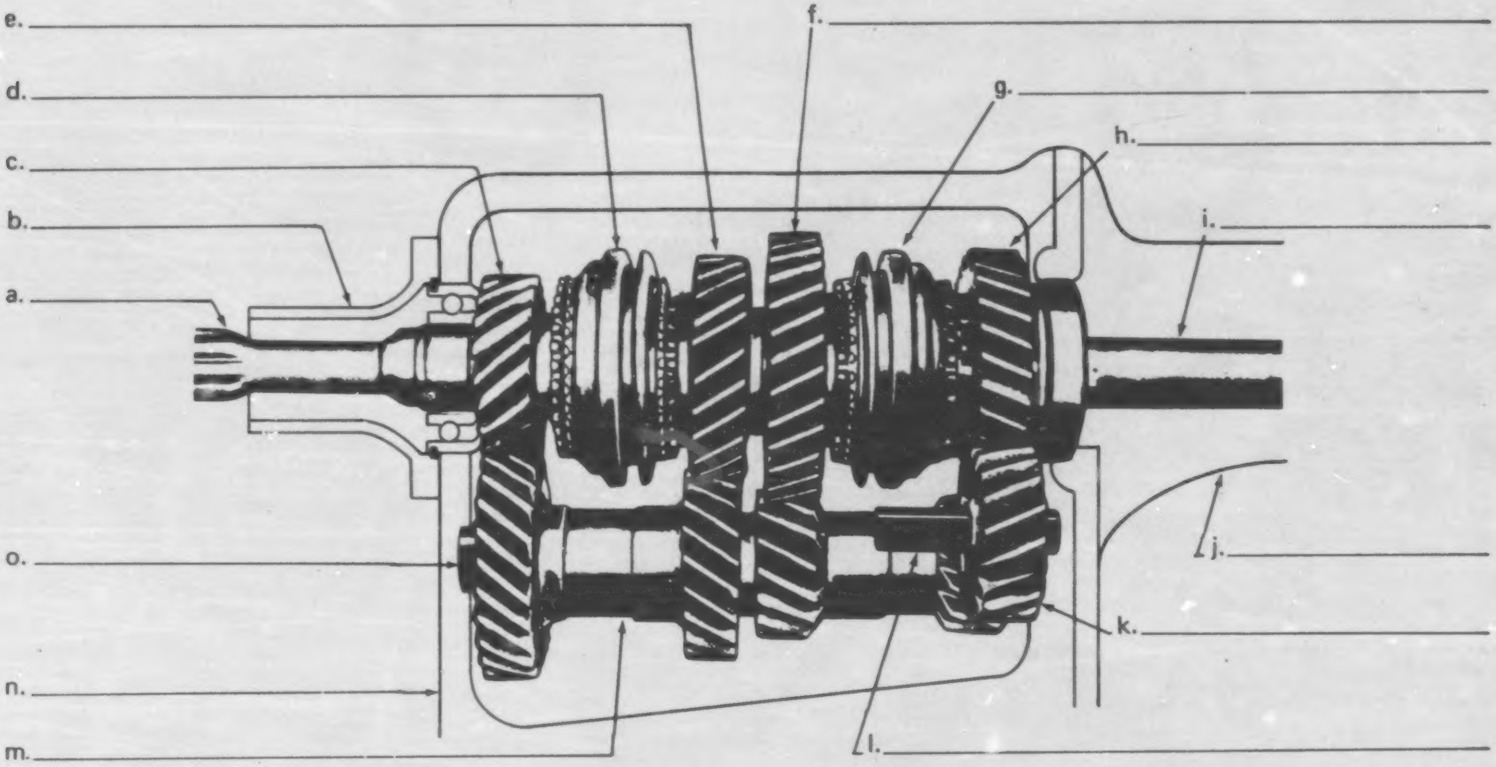
____

10. Discuss purpose of transmission.

____

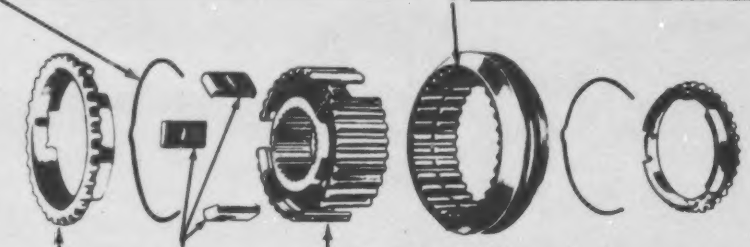
____

11. Label parts of transmission illustrated below. Write the correct names in the blanks provided.


e.
f.
d.
g.
h.
c.
b.
i.
a.
o.
j.
k.
n.
m.
l.

12. Identify parts of synchronizer illustrated below. Write correct names in the blanks provided.

a. ______________________ b. ______________________



Synchronizer ring

Inserts

Hub

Sleeve

Insert springs

e. ______________________

d. ______________________

c. ______________________

13. Explain how to shift gears when machine is moving.

a. Low to high

____

____

____

____

b. High to low

____

____

____

____

14. Discuss how shifting is done through low, intermediate, and high range.

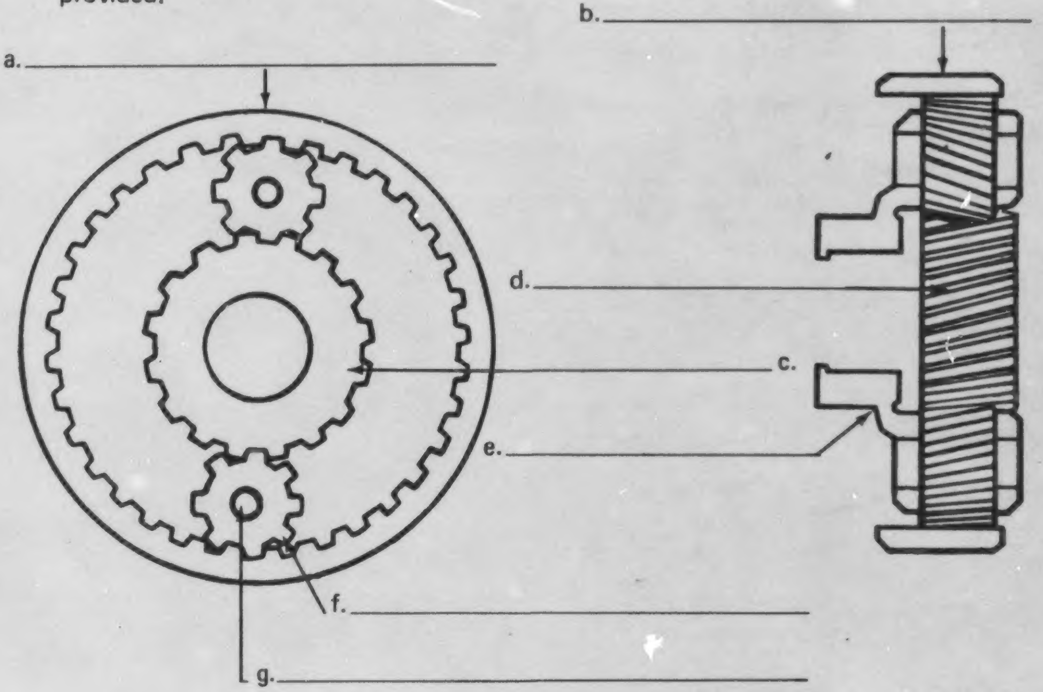
____

____

____

____

15. Label components of gear set illustrated below. Write the correct names in the blanks provided.



16. Select from the following list characteristics of planetary gear set. Write an "X" in the correct blanks.

_____a. No teeth in contact creates less friction

_____b. Side loads on gears for better load distribution

_____c. Prolonged operation in gear reduction mode not harmful

_____d. No side loads on gears for increased output

_____e. Gears always in mesh

17. List five available planetary gear combinations.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

18. Select from the following list gear ratio principles. Write an "X" in the correct blanks.

_____a. Increased power increases torque

_____b. Increased ratio decreases power output

_____c. Decreased ratio decreases power output

_____d. Decreased power decreases speed

_____e. Decreased power increases speed

_____f. Increased power decreases speed

19. Describe the direct drive mode-- ____

____

____

20. Describe the speed reduction mode.

a. ____

b. ____

c. ____

21. Describe the reverse gear mode.

a. ____

b. ____

c. ____

d. ____

22. Match the results on the right to the operating conditions of a planetary system.

_____a. Sun gear is driven
Ring gear is held
Carrier drives

_____b. Carrier is driven
Sun gear is held
Ring gear drives

_____c. Sun gear driven
Carrier is held
Ring gear drives

_____d. Carrier is driven
Ring gear is held
Sun gear drives

_____e. Ring gear is driven
Carrier is held
Sun gear drives

1. Speed increase
2. Speed reduction
3. Reverse
(speed reduction)
4. Reverse
(speed increase)
5. Direct drive

______f. Ring gear is driven
Sun gear is held
Carrier drives

______g. Any two of the units are locked together

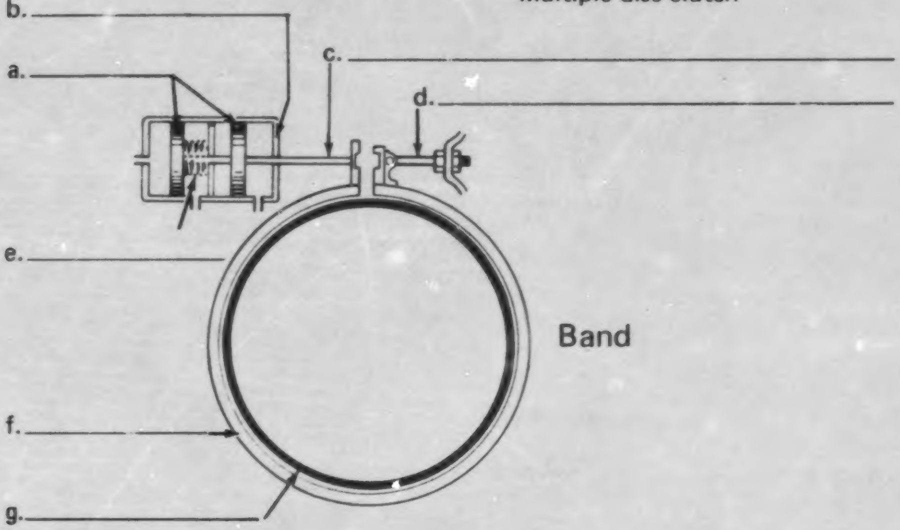
23. Identify planetary gear set controls and components in the illustrations below. Write the correct names in the blanks provided.

BAND

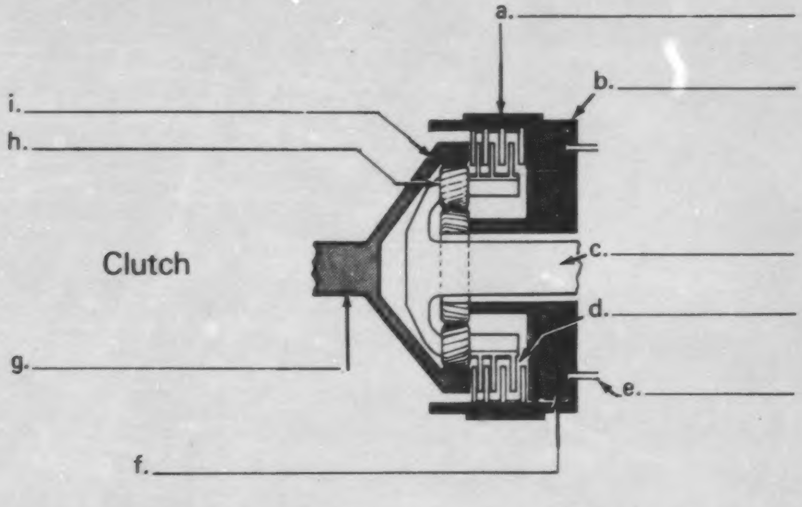
- Pistons
- Servo
- Stem
- Anchor
- Brake drum
- Sun gear brake band
- Retracting spring

CLUTCH

- Brake band
- Drum and sun gear
- Oil line
- Annular piston
- Internal gear
- Multiple disc clutch
- Output shaft and planet pinion carrier
- Input shaft
- Planet pinion

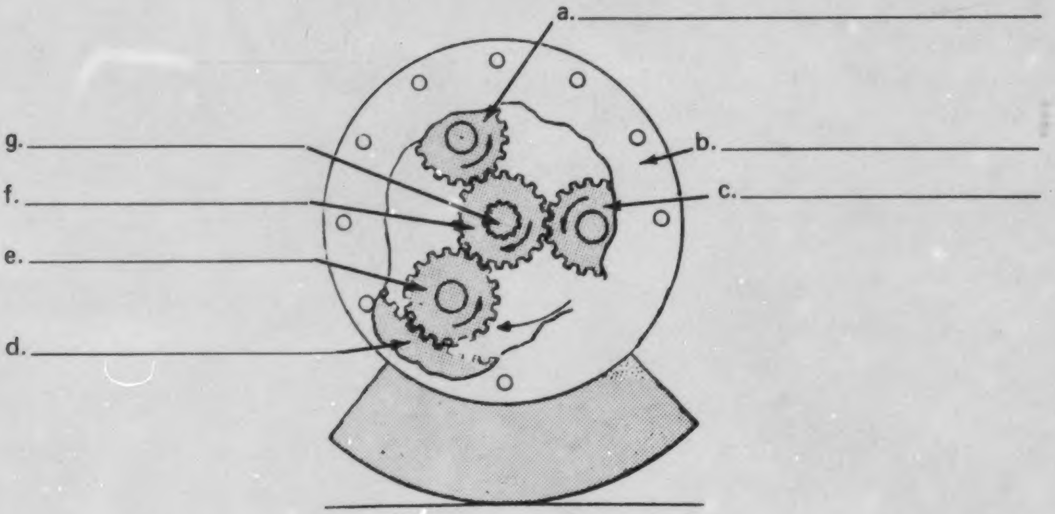


Band



Clutch

24. Label components of differential planetary or sun gear set illustrated below. Write the correct names in the blanks provided.



25. Explain how reduction in speed and increase in torque is accomplished.

a. ______

b. ______

c. ______

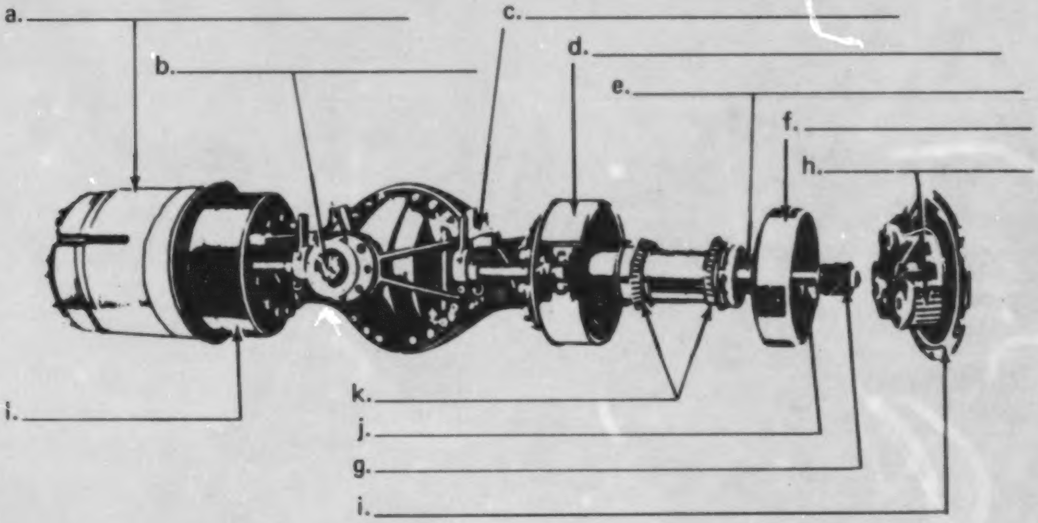
d. ______

______

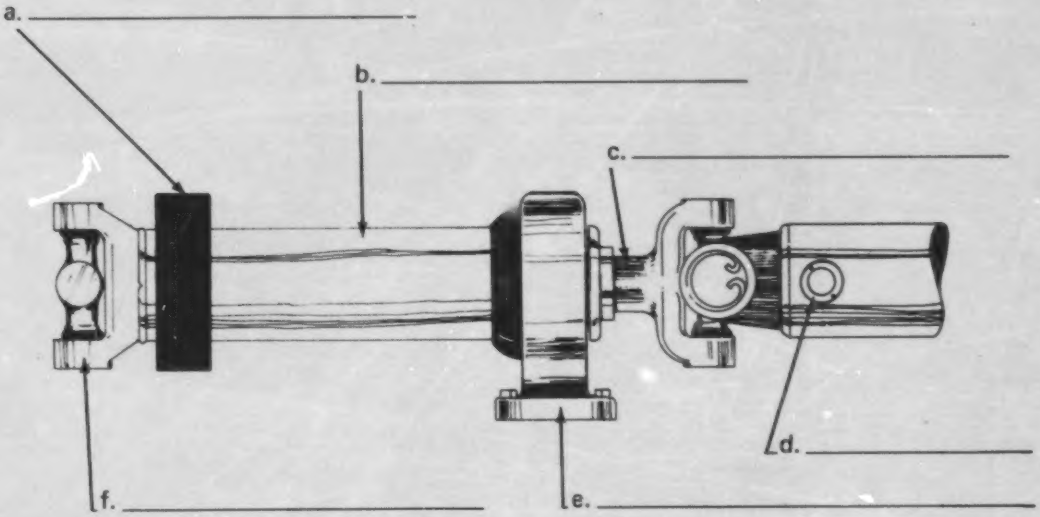
______

26. Identify components of the axle housing and final drive illustrated below. Write the correct names in the blanks provided.

Hub
Sun pinion
Ring splines
Brake drum
Live axle
Ring gear
Brake
Drive shaft
Planet gears
Hub bearings
Axle housing
Carrier & flange

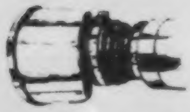


27. Label components of propeller shaft (drive shaft) illustrated below. Write the correct names in the blanks provided.

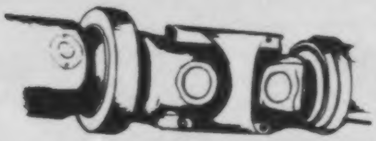


28. Identify types of U-joints illustrated below. Write correct names in the blanks provided.

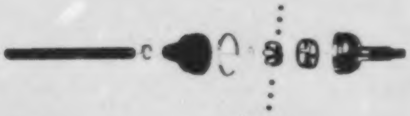
Cross and roller
Ball and trunnion
Constant velocity
Rzeppa



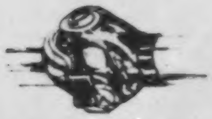
a. ______________________________



b. ______________________________

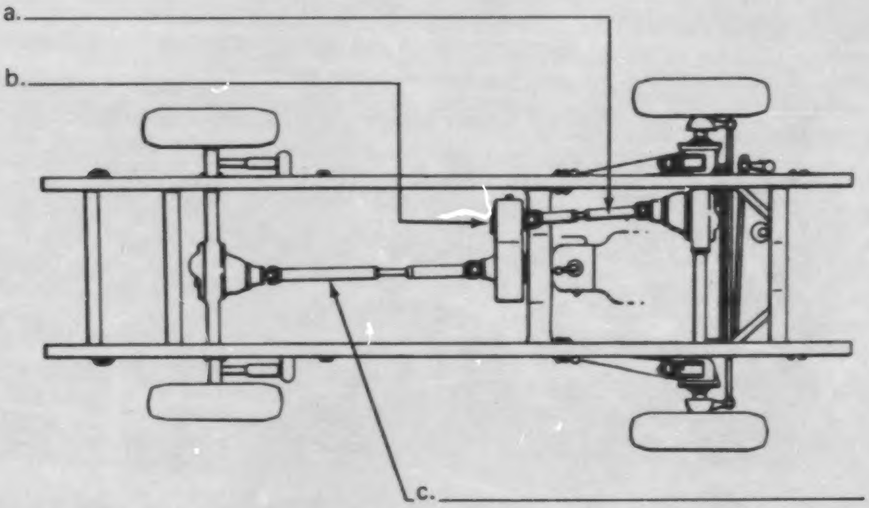


c. ______________________________



d. ______________________________

29. Label major components of the four-wheel drive vehicle illustrated below. Write the correct names in the blanks provided.



30. Discuss purposes of torque converters.

31. Match basic components of a torque converter to their purposes. Write the correct numbers in the blanks provided.

_____a. Driving member of converter which drives transmission oil pump and encloses rear of converter

_____b. Is splined to and drives transmission input shaft; set in motion by fluid from impeller vanes

_____c. Stationary set of vanes in converter used to cause torque multiplication

_____d. Encloses converter at engine (front) end; connected to engine drive plate

1. Turbine
2. Converter cover
3. Impeller
4. Stator

32. Discuss purposes of the stator.

a. ______________________________

b. ______________________________

33. State three principles of torque multiplication.

a. ______________________________

b. ______________________________

c. ______________________________

34. Select from the following list causes of overheating in a torque converter. Write an "X" in the correct blanks.

_____a. Operating in high temperatures

_____b. Insufficient temperature

_____c. Air in fluid system

_____d. Travelling too slowly

_____e. Overloading

35. Select from a list characteristics of hydraulics. Write an "X" in the correct blanks.

_____a. Liquids have a specific shape of their own

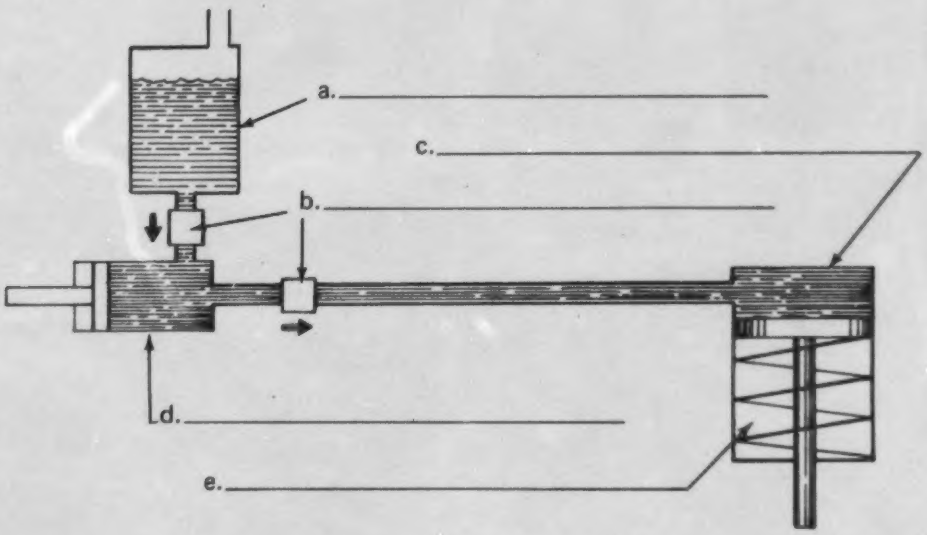
_____b. Liquids in a confined space can be used to transmit force

_____c. Liquids will compress

_____d. Liquids transmit applied pressure in all directions

_____e. Liquids provide great increases in work force

36. Label components of the basic hydraulic system illustrated below. Write the correct names in the blanks provided.



37. Name two types of hydraulic systems.

a. ______________________________

b. ______________________________

38. Select from the following list functions of the hydraulic system. Write an "X" in the correct blanks.

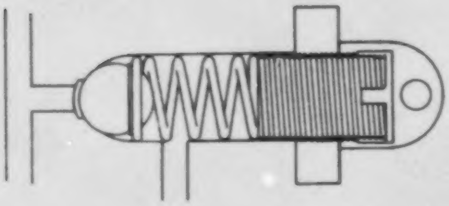
_____a. Cleans and lubricates the moving parts of the system

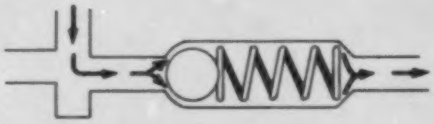
_____b. Provides cooling to dissipate heat

_____c. Applies pressure to the many pistons, control valves, and other moving parts

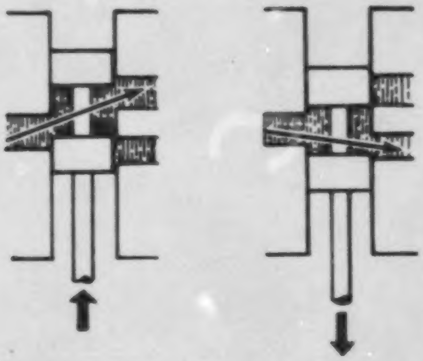
_____d. Provides a constant flow of hydraulic fluid under pressure to operate the system

39. Label types of hydraulic control valves illustrated. Write the correct names in the blanks provided.





a. ______________________ b. ______________________



c. ______________________

40. Distinguish between mechanical and hydraulic balanced directional control valves. Write an "M" in the blank pertaining to mechanical, and an "H" in the blank pertaining to hydraulic.

    _____a. Produces changes in output fluid pressure proportional to the movement of mechanical linkages connected to one end of valve

    _____b. Produces changes in output fluid pressure proportional to varying control fluid pressure which acts on one end of valve

41. Demonstrate the ability to:

    a. Adjust clutch linkage free travel.

    b. Shift a power shift transmission.

    (NOTE: If the activities in number 41 have not been finished before the test, ask the instructor when they should be completed.)

DRIVE TRAIN
UNIT II

ANSWERS TO TEST

1. a. 7
   b. 12
   c. 2
   d. 9
   e. 1
   f. 5
   g. 11
   h. 6
   i. 3
   j. 13
   k. 4
   l. 8
   m. 10
   n. 22
   o. 14
   p. 19
   q. 26
   r. 15
   s. 20
   t. 17
   u. 25
   v. 16
   w. 21
   x. 24
   y. 23
   z. 18
   aa. 29
   bb. 32
   cc. 31
   dd. 27
   ee. 30
   ff. 28

2. a. Torque converter
   b. Clutch
   c. Transmission
   d. Propeller shaft (drive shaft)
   e. Differential
   f. Axle
   g. Wheels

3. a. Pressure plate
   b. Flywheel ring (cover)
   c. Release sleeve retainer
   d. Adjusting ring
   e. Release bearing (throwout bearing) and sleeve assembly
   f. Driven front disc
   g. Intermediate plate
   h. Driven rear disc
   i. Release sleeve retainer

4. a. Return spring
   b. Pin
   c. Brake plate
   d. Release lever
   e. Rear driving plate

- f. Front driving disc
- g. Driven plate
- h. Driven plate
- i. Clutch shaft
- j. Ring
- k. Spring
- l. Flywheel
- m. Clutch cover plate
- n. Release bearing assembly
- o. Support assembly
- p. Stud
- q. Spring
- r. Lined plate

5. Description should include:
   - a. Engaged--Spring pressure clamps clutch disc between pressure plate and flywheel face
   - b. Disengaged--Release bearing and linkage release spring pressure

6. Answer should include:
   - a. Mechanical--Links, levers, or rods transfer motion from clutch pedal or control lever to release fork
   - b. Hydraulic--Master cylinder and slave cylinder transfers motion from clutch pedal or control lever to release fork

7. a. 4
   b. 6
   c. 1, 4, 8
   d. 3
   e. 4
   f. 8
   g. 2
   h. 5
   i. 1, 4, 8
   j. 8
   k. 6
   l. 7
   m. I
   n. 4
   o. 2
   p. 5

8. a, b, e, f, h, i, k, l, m

9. Description should include: Small brake that stops clutch shaft when clutch is fully disengaged, preventing shaft from spinning and delaying gear shifting

10. Discussion should include: Provides a change or changes in speed-power ratio of an engine driven shaft

11. a. Input shaft (clutch shaft)
    b. Input shaft bearing retainer
    c. Input shaft gear (main drive gear)
    d. Second and third gear synchronizer assembly
    e. Second speed gear
    f. First speed gear
    g. First and reverse synchronizer assembly
    h. Reverse gear
    i. Output shaft (main shaft)
    j. Extension housing
    k. Reverse idler gear
    l. Reverse idler gear shaft
    m. Counter or cluster gear
    n. Transmission case
    o. Counter shaft

12. a. Insert spring
    b. Sleeve
    c. Synchronizer ring
    d. Inserts
    e. Hub

13. Answer should include:
    a. Low to high
        1) Disengage engine clutch to take load off gears
        2) Shift into neutral
        3) If engine throttle is closed, reduce waiting period by double-clutching while in neutral
        4) Shift to high gear
    b. High to low
        1) Shift to neutral
        2) Engage clutch
        3) Speed up engine
        4) Disengage clutch
        5) Complete shift

14. Answer should include: Shifting is done by means of a control valve that directs hydraulic pressure to multiple disc clutches; these clutches are used to hold or release parts of the gear train to direct power through other parts.

15. a. Ring gear
    b. Ring gear
    c. Sun gear
    d. Sun gear
    e. Planet pinion carrier
    f. Planet pinion gear
    g. Planet pinion carrier

16. c, d, e

17. a. Direct drive
    b. Speed increase
    c. Speed reduction
    d. Reverse
    e. Neutral

18. c, e, f

19. Answer should include: Planetary gear set turns as a unit when any two components are locked together, no matter which component is driven

20. Answer should include:
    a. Ring gear is driven
    b. Sun gear is held
    c. Planet carrier provides output torque

21. Answer should include:
    a. Sun gear is driven
    b. Planet pinion carrier is held
    c. Planet pinion gears turn opposite sun gear
    d. Ring gear is forced by planet pinion gears to turn opposite sun gear

22. a. 1
    b. 2
    c. 4
    d. 2
    e. 3
    f. 1
    g. 5

23.

Band	Clutch
a. Piston	a. Brake band
b. Servo	b. Drum and sun gear
c. Stem	c. Output shaft and planet pinion carrier
d. Anchor	d. Multiple-disc clutch
e. Retracting spring	e. Oil line
f. Sun gear brake band	f. Annular piston
g. Brake drum	g. Input shaft
	h. Planet pinion
	i. Internal gear

24.
- a. Planet gear
- b. Driving flange
- c. Planet gear
- d. Stationary ring gear
- e. Planet gear
- f. Sun pinion (gear)
- g. Axle shaft

25. Answer should include:
- a. Power is supplied to the axle
- b. Work is performed by members attached to or driven by the flange
- c. Turning of the sun gear causes planets to rotate
- d. Rotation forces planets to "walk" around the tooth track formed by the ring gear, pulling the carrier or spider around with them in the same direction the axle rotates

26.
- a. Hub
- b. Drive shaft
- c. Axle housing
- d. Brake
- e. Ring splines
- f. Ring gear
- g. Sun pinion
- h. Planet gears
- i. Carrier or flange
- j. Live axle
- k. Hub bearings
- l. Brake drum

27. a. Torsional damper
    b. Shaft
    c. Slip joint
    d. Balance weight
    e. Center bearing support (carrier bearing)
    f. U-joint

28. a. Ball and trunnion
    b. Constant velocity
    c. Rzeppa
    d. Cross and roller

29. a. Front propeller shaft
    b. Transfer case
    c. Rear propeller shaft

30. Discussion should include:
    a. Acts as a fluid coupling to connect engine power through oil to the transmission gear train
    b. Multiplies torque from the engine when additional performance is desired
    c. Acts as a flywheel for the engine

31. a. 3
    b. 1
    c. 4
    d. 2

32. Discussion should include:
    a. Changes fluid flow from opposing direction to helping direction when speed difference between turbine and impeller is high
    b. Moves with fluid flow when there is little or no speed difference between turbine and impeller

33. Any three of the following:
    a. Curved vanes allow fluid to change direction gradually
    b. Curved impeller vanes throw fluid forward into turbine vanes
    c. Fluid leaving turbine vanes strikes impeller vanes at 90° and opposes driving force of impeller
    d. Torque is lost due to bounce-back effect

e. Stator with sharply curved vanes is positioned between trailing edge of turbine vanes and leading edge of impeller vanes

f. Direction of fluid is changed by the stator so that the force of the fluid strikes the impeller blades and then is directed into turbine so that any remaining energy is exerted on the turbine thus multiplying torque

34. a, c, e

35. b, d, e

36. a. Reservoir

b. Check valves

c. Cylinder

d. Pump

e. Spring

37. a. Hydrostatic

b. Hydrodynamic

38. a, b, c, d

39. a. Pressure relief valve

b. Check valve

c. Directional control valve

40. a. Mechanical

b. Hydraulic

41. Performance skills evaluated to satisfaction of instructor

PREVENTIVE MAINTENANCE
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to perform preventive maintenance on heavy equipment, and complete appropriate maintenance records. This knowledge will be evidenced by completion of assignment sheets, job sheets, and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with preventive maintenance to the correct definitions.
2. Select from a list factors that should be included in preventive maintenance.
3. Select from a list items to check in a visual inspection.
4. Identify items that should be checked on a daily (or shift) checklist.
5. Select from a list types of preventive maintenance inspections.
6. Label safe service positions.
7. Identify types of grease guns and grease fittings.
8. Label main parts of the cooling system.
9. State purpose of the cooling system.
10. Complete daily (or shift) preventive maintenance inspection.
11. Complete a 50-hour preventive maintenance inspection.
12. Complete a 250-hour preventive maintenance inspection.
13. Complete a 1000-hour preventive maintenance inspection.
14. Demonstrate the ability to:
    a. Lubricate a wheel loader.
    b. Lubricate a hydraulic crawler excavator.

PREVENTIVE MAINTENANCE
UNIT III

SUGGESTED ACTIVITIES

I. Suggested activities for instructor:

  A. Provide student with objective sheet.

  B. Provide student with information, assignment, and job sheets.

  C. Make transparency.

  D. Discuss unit and specific objectives.

  E. Discuss information and assignment sheets.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Caution students as to use and care of tools.

  H. Caution students as to safety and service position of machines.

  I. Procure daily record books for each student.

  J. Reproduce or obtain monthly record sheets for students to fill out.

  K. Use manufacturer's maintenance guides for particular equipment when performing preventive maintenance inspections.

  L. Give test.

II. Instructional materials:

  A. Objective sheet

  B. Information sheet

  C. Transparency master: TM 1--Engine Cooling System

  D. Assignment sheets

  (NOTE: Assignment sheets will be used and graded at the discretion of the instructor.)

    1. Assignment Sheet #1--Complete Daily (or Shift) Preventive Maintenance Inspection

    2. Assignment Sheet #2--Complete 50-Hour Preventive Maintenance Inspection

    3. Assignment Sheet #3--Complete 250-Hour Preventive Maintenance Inspection

4. Assignment Sheet #4--Complete 1000-Hour Preventive Maintenance Inspection

E. Job sheets

1. Job Sheet #1--Lubricate a Wheel Loader

2. Job Sheet #2--Lubricate a Hydraulic Crawler Excavator

F. Test

G. Answers to test

III. Unit references:

A. *Clark Operators Manual No. 3232, 75B Michigan Tractor Shovel.* Benton Harbor, Michigan: Clark Equipment Company, n. d.

B. *Preventive Maintenance Guide for Tractor Shovels.* Benton Harbor, Michigan: Clark Equipment Company, n. d.

C. Nichols, Herbert L., Jr. *Moving the Earth.* Greenwich, Connecticut: North Castle Books, 1976.

D. Nichols, Herbert L., Jr. *Heavy Equipment Repair.* Greenwich, Connecticut: North Castle Books, 1969.

E. *Operators Instructions 325H.* South Milwaukee, Wisconsin, Bucyras-Erie Company, 1978.

PREVENTIVE MAINTENANCE
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Preventive maintenance (PM)--Taking care of equipment systematically to reduce repairs

   B. Lubricant--Substance that reduces friction between surfaces

   C. Grease--Thick lubricant

   D. Alemite--Type of grease

   E. Sender unit--Operating safety feature for gages

   F. Honing stone--Device containing several oblong abrasive stones arranged in a circular pattern; used to remove small amounts of material from cylindrical surfaces

   G. Sediment--A solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid

   H. Packing gland--Device preventing leakage at a machine joint

   I. SAE number--A classification of motor, transmission, and differential lubricants to indicate viscosities standardized by the Society of Automotive Engineers; SAE numbers do not connote quality of lubricant

   J. Kilopascal (kPa)--Metric unit of pressure similar to psi (pounds per square inch)

   K. Drag link--A four-bar linkage in which both cranks traverse full circles; the fixed member must be the shortest link

II. Factors that should be included in preventive maintenance (Assignment Sheet #1)

   A. Inspections

   B. Scheduled service

   C. Scheduled lubrication

   D. Frequent cleaning of equipment

   E. Adjustments

   F. Prompt correction of defects

   G. Complete and accurate records

INFORMATION SHEET

III. Items that should be checked in visual inspection

(NOTE: Visual inspection means to walk completely around machine looking for and recording any damage or defects.)

- A. Leaks, or streaks that may indicate leaks
- B. Damage and condition of tires and/or tracks and under carriage
- C. Engine damage
- D. Lights, for damage
- E. Radiator
- F. Switches and controls
- G. Levers, rods, caps, fittings, cylinder, and rods
- H. Dirt accumulation that could be harmful to machine
- I. Fluid levels on all components
- J. Condition of windshield wipers (when applicable)
- K. Condition of attachments or accessories

IV. Items on daily (or shift) checklist (Assignment Sheet #2)

- A. Visual inspection

INFORMATON SHEET

B. Tires and tire pressure

JD544-B
JOHN DEERE

C. Engine oil level

INFORMATION SHEET

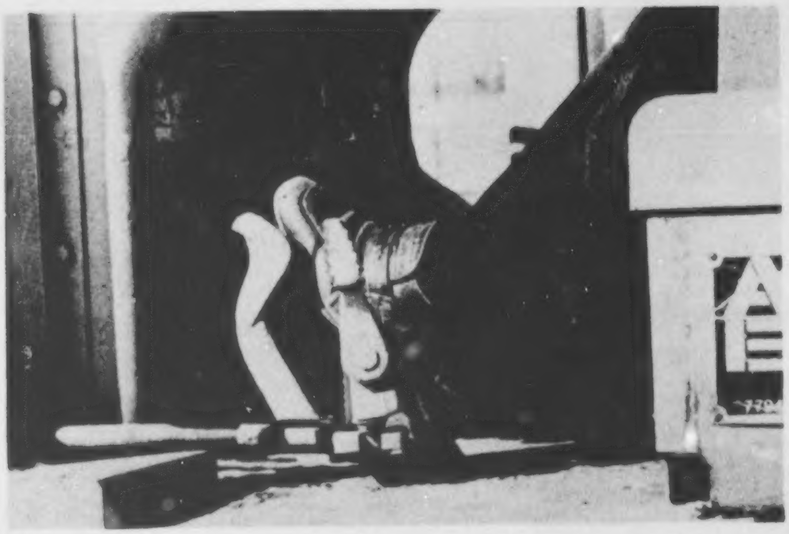
D. Transmission fluid level

E. Battery electrolyte level; battery connections

INFORMATION SHEET

F. Hydraulic system

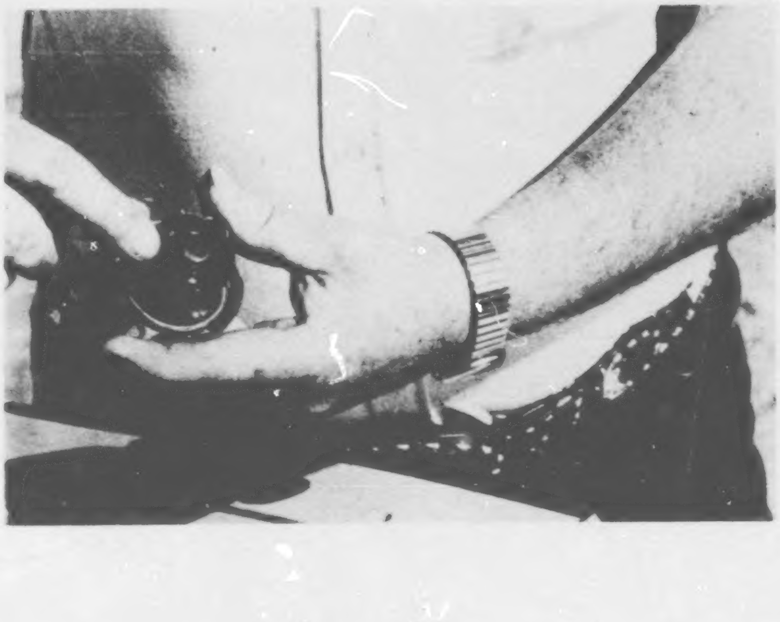
G. Brakes (testing with foot pedal)



INFORMATION SHEET

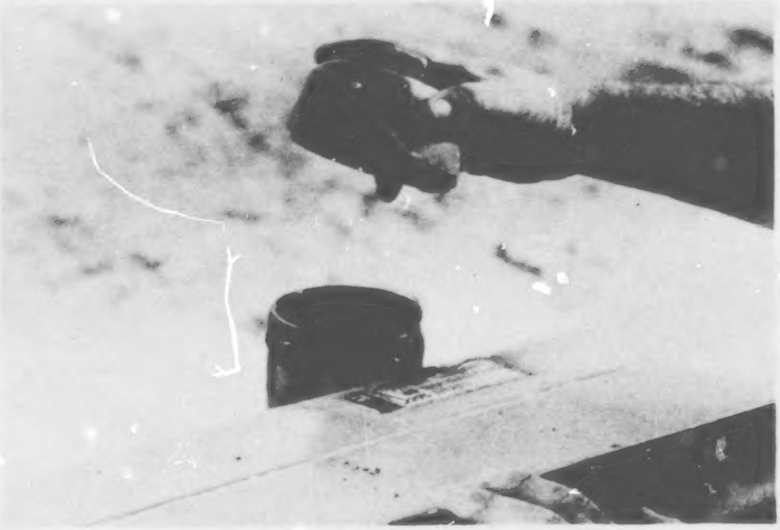
H. Air cleaner indicator

I. Cooling system level and pressure cap



INFORMATION SHEET

J. Fuel system and supply



K. Hydraulic fluid level on sight glass and/or dip stick

INFORMATION SHEET

L. Insulation and connections on wires in electrical system

V. Types of preventive maintenance inspections (Assignment Sheets #1, #2, #3, and #4)

A. Visual

B. Daily

C. 50-Hour

D. 250-Hour

E. 1000-Hour

(NOTE: Follow manufacturer's recommendations for prescribed inspections.)

VI. Safe service positions

(NOTE: The following positions are for a wheel loader.)

INFORMATION SHEET

A. Attachment on ground

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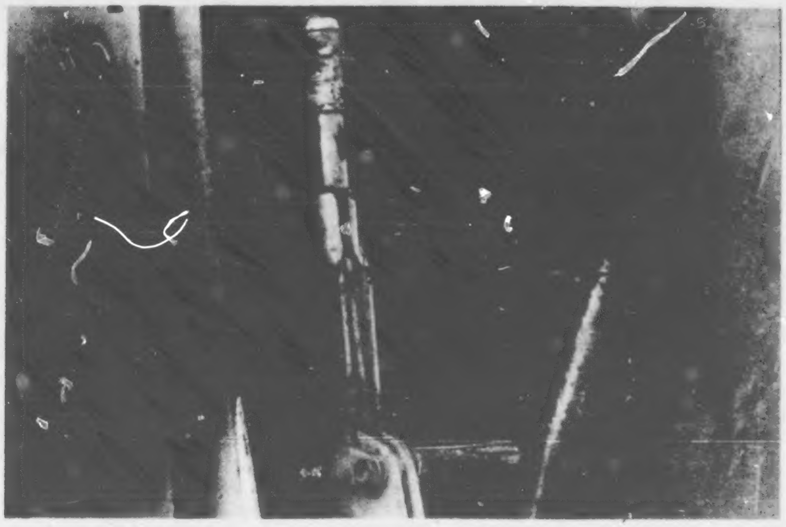
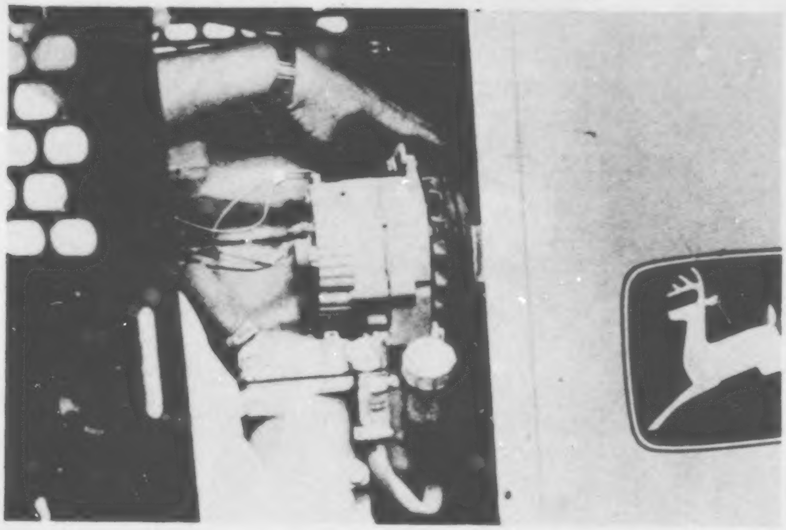
JD544-B

B. Parking brake applied



INFORMATION SHEET

C. Engine stopped



D. Ignition key removed

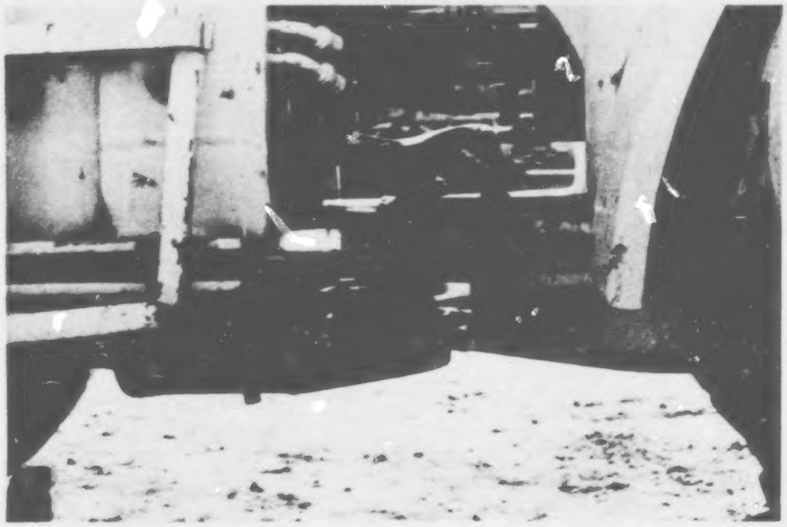
INFORMATION SHEET

E. Steering wheel tagged

DANGER
DO NOT OPERATE

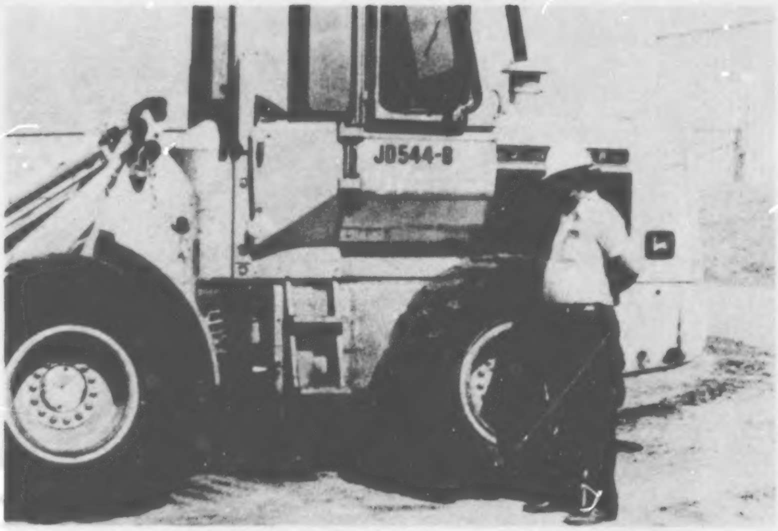
F. Safety link connected

(NOTE: This service position pertains to articulated loader only.)



INFORMATION SHEET

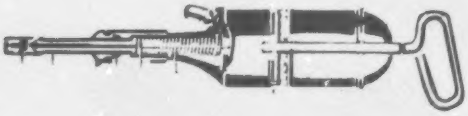
G. Wheels blocked



VII. Types of grease guns and grease fittings

A. Grease guns

1. Push-type handgun



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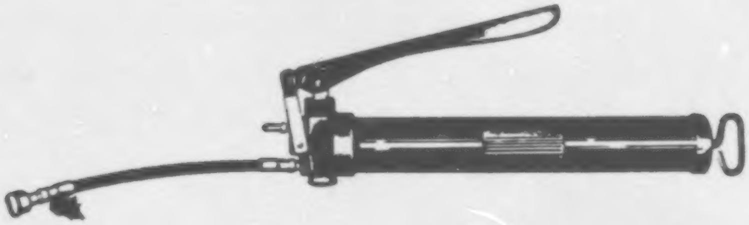
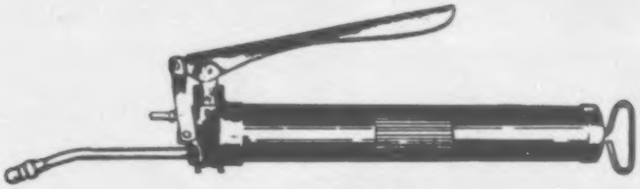
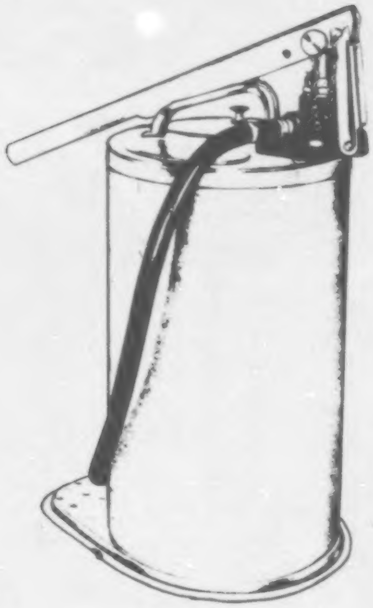
INFORMATION SHEET

2. Lever-type handgun



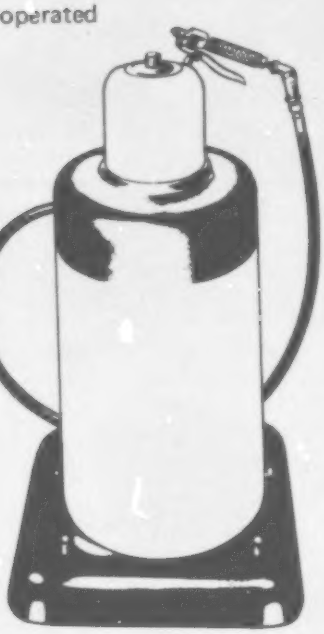


3. Volume pressure bucket pump

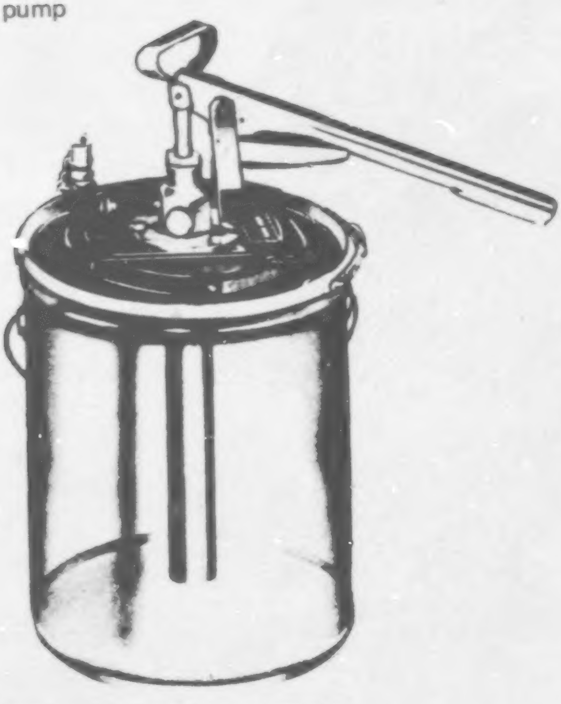


INFORMATION SHEET

4. Portable air operated



5. Pail cover pump



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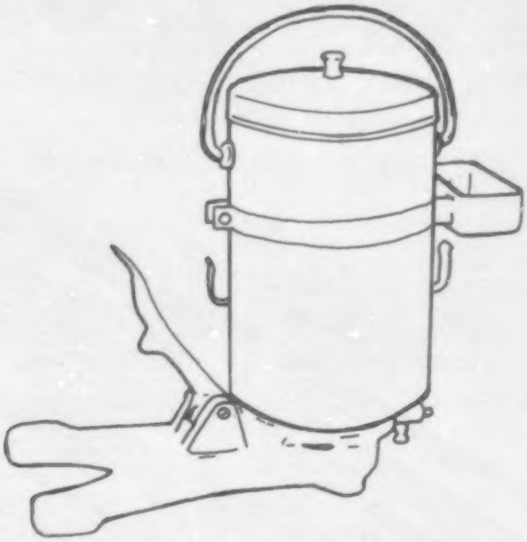
INFORMATION SHEET

6. Foot-lever bucket pump



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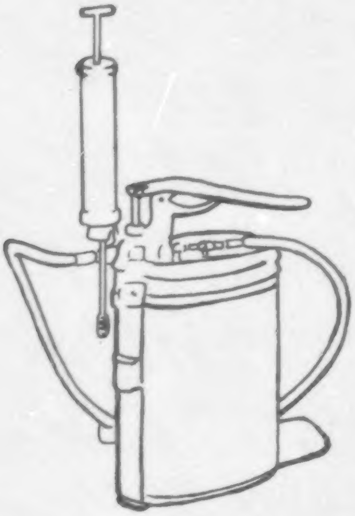
7. Handgun loader



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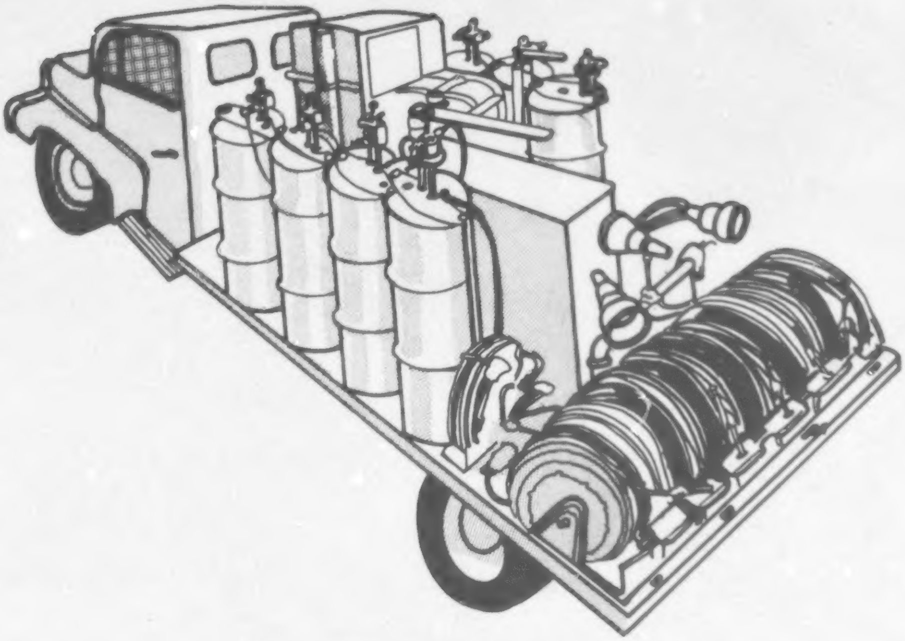
INFORMATION SHEET

8. Grease truck



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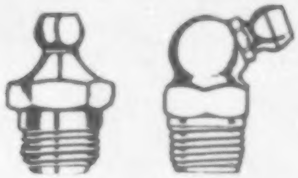
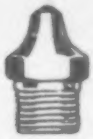
INFORMATION SHEET

B. Grease fittings

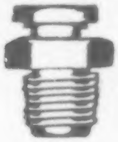
1. Hydraulic fittings



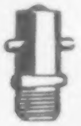
2. Zerk fitting



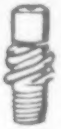
3. Buttonhead fitting (takes special attachment)



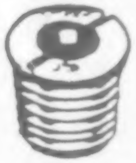
4. Alemite® fitting (takes special attachment)



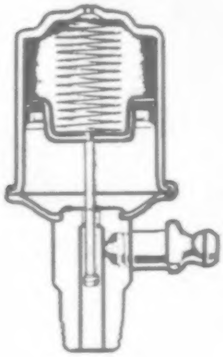
5. Dot fitting (takes special attachment)



6. Flush fitting (takes special attachment)



7. Reservoir fitting



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INFORMATION SHEET

VIII. Main parts of cooling system (Transparency 1)

A. Radiator

B. Water pump

C. Water pump air vent line

D. Bypass

E. Thermostat (regulator)

F. Cylinder head

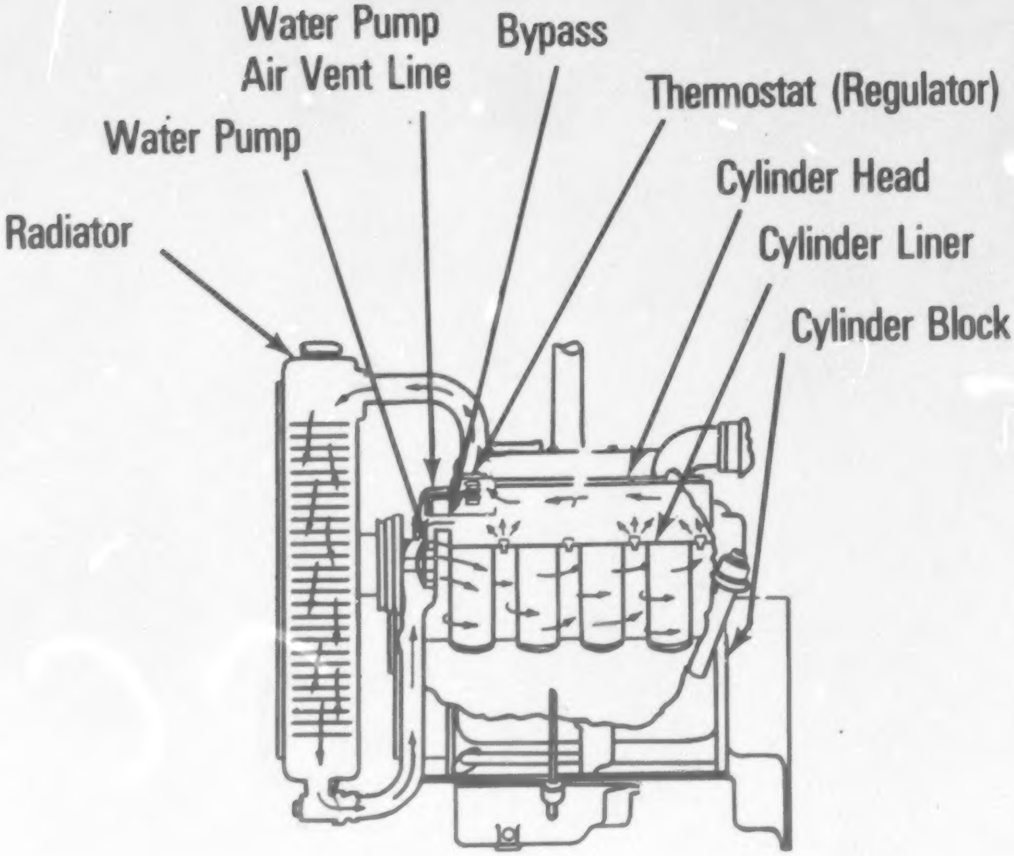
G. Cylinder liner

H. Cylinder block

IX. Purpose of cooling system--To remove heat from the cylinder walls and combustion chambers through the radiator

(NOTE: Only part of the energy in fuel is converted to usable energy in an engine; the balance is turned into heat. Most of the heat goes out the exhaust, but, if it is not removed, enough remains to completely destroy the engine in a few minutes.)

Engine Cooling System


Water Pump
Air Vent Line
Bypass
Thermostat (Regulator)
Water Pump
Cylinder Head
Radiator
Cylinder Liner
Cylinder Block

PREVENTIVE MAINTENANCE
UNIT III

ASSIGNMENT SHEET #1--COMPLETE DAILY (OR SHIFT) PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________________ SCORE ____________

1. **VISUAL INSPECTION**
    a. Walk entirely around machine, looking for leaks or streaks
    b. Look for damage to tires, engine, lights, and radiator
    c. Examine switches, controls, levers, rods, caps, fittings
    d. Remove any dirt or material large enough to be a hazard

    (Do not attempt to operate a damaged machine)
2. **TIRES AND UNDER CARRIAGES**
    a. Check tire pressure, and inspect tread condition
    b. Examine valves, and reinstall caps
    c. Do not operate machine with a defective tire
3. **ENGINE (Refer to engine manufacturer's manual)**
    a. Check oil level, noticing dirt or grit, and leaks
    b. Drain and refill crankcase if required
4. **TRANSMISSION AND TORQUE CONVERTER**
    a. Check for leaks
    b. Check oil level, noting condition of oil
    c. Drain and change oil if required
5. **LUBRICATION**--Lubricate all daily (or shift) fittings following instructions on lubrication chart
6. **CENTRAL LUBRICATION SYSTEM** (if applicable)
    a. Refill grease barrel
    b. Check lines, manual operation, and fittings

    (NOTE: If barrel has been allowed to run dry, pump grease through system with pressure gun to remove all air at each lube port.)

ASSIGNMENT SHEET #1

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #1

7. **BRAKES**--Check operation of service (wheel) brakes, parking brake, and safety brake system

   (NOTE: If brake lines leak, or if system components need repair or replacement, do not operate machine until condition has been corrected.)

8. **AIR CLEANER INDICATOR**

   a. Service elements when indicator shows red

   b. Clean or replace elements as required

      (NOTE: It may be necessary to do this more than once a day.)

9. **COOLING SYSTEM**

   a. Check coolant level, and refill if required (note quantity)

   b. Check anti-freeze protection, if used

10. **FUEL SYSTEM**

    a. Examine all "quick start" connections for leaks (during cold weather)

    b. Check fuel tank level (note quantity)

11. **HYDRAULIC SYSTEM**--Refer to manufacturer's recommendations

12. **AIR TANKS**

    a. If machine does not have air dryer, drain off moisture

    b. Replace air dryer dessicant if required

ASSIGNMENT SHEET #1

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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PREVENTIVE MAINTENANCE
UNIT III

ASSIGNMENT SHEET #2--COMPLETE 50-HOUR PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________ SCORE ______________

(NOTE: Use with Daily List.)

Check (✓), Repair (R), or Adjust (A)

1. **ENGINE (Refer to engine manufacturer's manual)**
   a. Check and adjust belt tension . . . . ☐
   b. Tighten air cleaner connections. . . . . ☐
2. **TORQUE CONVERTER AND TRANSMISSION**
   a. Replace all filter elements and clean converter cooler line . . . . ☐
   b. Clean breathers in solvent, and blow dry. . . . . ☐
3. **DIFFERENTIALS, PLANETARY HUBS, MIDMOUNT BEARING**
   a. Check front axle differential oil level . . . . ☐
   b. Check front axle planetary hub oil level . . . . ☐
   c. Check rear axle differential oil level . . . . ☐
   d. Check rear axle planetary hub oil level . . . . ☐
   e. Check midmount bearing oil level . . . . ☐
4. **FUEL SYSTEM**
   a. Drain water and sediment from fuel tank . . . . ☐
   b. Test operation of "quick start" unit (during cold weather) . . . . ☐
5. **ELECTRICAL SYSTEM**
   a. Service batteries . . . . ☐
   b. Check lights and instruments. . . . . ☐

ASSIGNMENT SHEET #2

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #2

6. HYDRAULIC SYSTEM

a. Clean cylinder rods, and remove nicks with fine honing stone. ☐

b. Check hydraulic system for leaks ☐

c. Clean and reinstall reservoir suction filter ☐

d. Replace reservoir return filter element ☐

7. STEERING SYSTEM

a. Clean cylinder rods with soft cloth ☐

b. Check hydraulic system for leaks ☐

8. BRAKES

a. Check brake chambers, power clusters, valves, and lines for leaks ☐

b. Check fluid level (disc brakes or air/hydraulics) ☐

c. Check hydraulic fluid level in parking brake reservoir ☐

d. Check brake air filter service indicator ☐

9. WHEELS AND RIMS

a. Tighten wheel nuts ☐

b. Inspect rims. ☐

10. LUBRICATION (per lubrication chart)

a. Lubricate brake camshafts. ☐

b. Lubricate all 50-hour and 100-hour fittings. ☐

CHECK PERFORMED BY ______________________ DATE ____________

REMARKS ____

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ASSIGNMENT SHEET #2

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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PREVENTIVE MAINTENANCE
UNIT III

ASSIGNMENT SHEET #3--COMPLETE 250-HOUR PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________________ SCORE ______________

(NOTE: Use with Daily List.)

Check (✓), Repair (R), or Adjust (A)

1. **ENGINE (Refer to engine manufacturer's manual)**
   - a. Drain and refill crankcase ☐
   - b. Change lube oil filter elements ☐
   - c. Check engine rpm (low idle, high idle, stall) ☐
   - d. Adjust throttle linkage ☐
   - e. Drain condensation from all air tanks ☐
   - f. Tighten all air cleaner connections ☐
   - g. Check coolant level and antifreeze protection ☐
   - h. Check and adjust belt tension ☐
2. **TORQUE CONVERTER AND TRANSMISSION**
   - a. Clean converter cooler line strainer ☐
   - b. Clean breathers in solvent and blow dry ☐
   - c. Replace filter elements ☐
3. **BOOM AND BUCKET SYSTEM**
   - a. Check hydraulic system for leaks ☐
   - b. Check and adjust cylinder packing glands ☐
   - c. Adjust bucket leveler ☐
   - d. Adjust boom kickout ☐
   - e. Service return filter ☐
   - f. Clean suction filter ☐

ASSIGNMENT SHEET #3

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #3

4. ELECTRICAL SYSTEM

a. Check lights, instruments, and circuit breakers or fuses. ☐

b. Check specific gravity of each battery cell. ☐

c. Check condition of battery cables and terminals. ☐

5. AXLES, DIFFERENTIALS, MIDMOUNT BEARING

a. Clean midmount breather ☐

b. Check midmount oil level ☐

c. Check front and rear differential breathers ☐

d. Check front and rear differential oil levels. ☐

e. Check front axle planetary hub oil levels. ☐

f. Check rear axle planetary hub oil levels. ☐

6. AUTOMATIC CENTRAL LUBRICATION SYSTEM

a. Check grease level and refill barrel. ☐

b. Test operation of "manual" button. ☐

c. Inspect lube indicators for blockage ☐

d. Check all lube points for grease. ☐

e. Machines without Automatic Lubrication System: Lubricate all 50-hour fittings per lubrication chart ☐

7. FUEL SYSTEM

a. Drain fuel tank sediment and water. ☐

b. Remove "quick start" cylinder and replace if required ☐

8. BRAKE SYSTEM

a. Check brake hydraulic accumulator precharge ☐

b. Adjust service brakes. ☐

c. Check and adjust parking brake. ☐

d. Disc Brakes Only:

1) Tighten brake disc mounting bolts, and bleed system; check lining wear ☐

ASSIGNMENT SHEET #3

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #3

    2) Check fluid level (disc brakes or air/hydraulics) . . . . ☐
    3) Check hydraulic fluid level in parking brake reservoir . . . . ☐
    4) Check brake air filter service indicator . . . . ☐

9. **OPERATOR'S SEAT**--Adjust and lubricate operator's seat. . . . . ☐

10. **LOWER HINGE PIN BUSHING**--Check and adjust. . . . . ☐

11. **ACCESSORIES**--Check operation of all accessories. . . . . ☐

CHECK PERFORMED BY ______________________ DATE __________

REMARKS ____

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ASSIGNMENT SHEET #3

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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PREVENTIVE MAINTENANCE
UNIT III

ASSIGNMENT SHEET #4--COMPLETE 1000-HOUR PREVENTIVE MAINTENANCE INSPECTION

NAME ______________________ SCORE ____________

(NOTE: Use with Daily List.)

Check (✓), Repair (R), or Adjust (A)

1. **GENERAL**
   - a. Steam clean entire machine ☐
   - b. Inspect main frame for cracks and damage ☐
   - c. Tighten mounting bolts on steering and propeller shafts ☐
2. **ENGINE (Refer to engine manufacturer's manual)**
   - a. Clean radiator core using compressed air, steam, or water pressure ☐
   - b. Drain, flush, and refill radiator to proper level and check antifreeze protection ☐
   - c. Drain and refill crankcase ☐
   - d. Change lube oil filter elements ☐
   - e. Torque engine mounting bolts per chart in operator's manual ☐
   - f. Check engine rpm (low idle, high idle, stall) ☐
   - g. Adjust throttle linkage ☐
   - h. Drain condensation from all air tanks ☐
   - i. Service air cleaner body ☐
3. **TORQUE CONVERTER AND TRANSMISSION**
   - a. Drain and refill torque converter and transmission ☐
   - b. Remove, clean, and reinstall transmission sump screen ☐
   - c. Check and adjust shift linkage ☐
   - d. Check transmission de-clutch valve ☐
   - e. Clean converter cooler line strainer ☐
   - f. Clean breathers in solvent and blow dry ☐

ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #4

g. Replace filter elements ☐
h. Check converter internal pressure ☐
i. Check transmission clutch, lube, and oil cooler pressure ☐
j. Tighten mounting bolts on transmission and converter ☐
k. Lubricate propeller shafts ☐

4. BOOM AND BUCKET SYSTEM

a. Check and adjust cylinder packing glands ☐
b. Check hydraulic system for leaks ☐
c. Drain, clean, and refill hydraulic system ☐
d. Check and adjust hydraulic pressure ☐
e. Adjust bucket leveler. ☐
f. Adjust boom kickout ☐
g. Service reservoir return filter assemblies ☐
h. Clean reservoir suction filter assemblies. ☐
i. Adjust boom and bucket control levers. ☐
j. Check condition of bucket cutting edges ☐
k. Check boom-to-bucket linkage ☐
l. Check and adjust main pump bypass pressure ☐

5. ELECTRICAL SYSTEM

a. Check alternator and starting motor ☐
b. Clean and tighten electrical connections ☐
c. Check lights, instruments, and circuit breakers (or fuses) ☐
d. Check specific gravity of each battery cell. ☐
e. Check condition of battery cables and terminals. ☐

6. AXLES, DIFFERENTIALS, MIDMOUNT BEARING

a. Lubricate propeller shafts ☐
b. Drain and refill midmount bearing ☐

ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #4

c. Clean front and rear axle breathers ☐

d. Clean front and rear differential breathers. ☐

e. Drain and refill front and rear axle differentials ☐

f. Drain and refill front axle planetary hubs ☐

g. Drain and refill rear axle planetary hubs ☐

h. Tighten front and rear axle mounting bolts. ☐

i. Clean midmount breathers ☐

7. AUTOMATIC CENTRAL LUBRICATION SYSTEM

a. Check grease level and refill barrel. ☐

b. Test operation of "manual" button. ☐

c. Inspect lube indicators for blockage ☐

d. Check all lube points for grease. ☐

e. Machines without Automatic Lubrication System:
Lubricate all 50-hour and 100-hour fittings per lubrication chart ☐

8. FUEL SYSTEM

a. Drain fuel tank sediment and water. ☐

b. Remove "quick start" cylinder, and replace if required. ☐

9. BRAKE AND STEERING SYSTEMS

a. Check brake hydraulic accumulator precharge ☐

b. Clean, repack, and adjust steering gear ☐

c. Adjust steering drag link ball joints ☐

d. Check steering pressure ☐

e. Check and adjust steering pump bypass rpm ☐

f. Adjust service brakes. ☐

g. Check and adjust parking brake. ☐

h. Disc Brakes Only:

1) Tighten brake disc mounting bolts and bleed system;
check lining wear. ☐

ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

ASSIGNMENT SHEET #4

2) Replace dessicant cartridge in air dryer if required ☐

3) Check brake air filter service indicator ☐

10. **OPERATOR'S SEAT**--Adjust and lubricate operator's seat ☐

11. **LOWER HINGE PIN BUSHING**--Check and adjust ☐

12. **ACCESSORIES**--Check operation of all accessories ☐

CHECK PERFORMED BY ______________________ DATE ____________

REMARKS ______________________________

ASSIGNMENT SHEET #4

DATE	MACHINE HOURS	CHECKED BY	RECORD PM CHECK, REPAIRS MADE, REPAIRS NEEDED

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ASSIGNMENT SHEET #4

INSPECTION REPORT

MODEL ____________ SERIAL NUMBER ____________

TRANSMISSION MODEL ____________ SERIAL NUMBER ____________

CONVERTER OIL TEMPERATURE ____________

(NOTE: All pressure checks, except clutch pressure, must be taken with transmission in neutral.)

CLUTCH kPa (psi) @ IDLE ____________

SPEEDS: 1st ______ 2nd ______ 3rd ______ 4th ______ Rev. ______

CONVERTER "IN" kPa (psi) @ 2000 rpm ____________

CONVERTER "OUT" kPa (psi) @ 2000 rpm ____________

(NOTE: Converter "out" will be the same as cooler "in" except for 34 kPa (5 psi) drop in the connecting line. Measure whichever is easier.)

COOLER "IN" kPa (psi) @ 2000 rpm ____________

COOLER "OUT" kPa (psi) @ 2000 rpm ____________

COOLER DROP kPa (psi) ____________

(NOTE: To calculate cooler drop: Subtract cooler "out" pressure from cooler "in" pressure
OR
Subtract cooler "out" pressure from converter "out" pressure
THEN
Subtract 34 kPa [5 psi].)

LUBE kPa (psi) @ 2000 rpm and HIGH FREE IDLE ____________

MAIN RELIEF kPa (psi) @ IDLE ____________

ENGINE rpm @ IDLE ____________ @ STALL ____________

DATE OF INSPECTION ____________ HOURMETER READING ____________

INSPECTED BY ____________

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PREVENTIVE MAINTENANCE
UNIT III

JOB SHEET #1--LUBRICATE A WHEEL LOADER

I. Tools and equipment

   A. Loader

   B. Grease gun

   C. Container of lithium base multi-purpose grease--Grade 2

   D. Shop rags

   E. Service manual and lubrication chart

   (NOTE: See next page for lubrication chart.)

II. Procedure

   A. Clean off grease fitting with rag

   B. Fill grease gun with proper lubricant

   C. Place gun nozzle on grease fitting and apply pressure to release grease

   (NOTE: The manufacturer's maintenance manual for particular piece of equipment will give locations of all grease fittings.)

   D. Proceed with steps A, B, and C, until all fittings have been greased

JOB SHEET #1

LUBRICATION CHART

INTERVAL	ITEM NO.	DESCRIPTION	KEY
DAILY ⊖	1.	Boom to Upper Pivot (1 fitting each side)	LBG
	2.	Bucket Cylinder to Frame (1 fitting each side)	LBG
	3.	Boom Cylinder to Frame (2 fittings each side)	LBG
	4.	Boom Cylinder to Boom (1 fitting each side)	LBG
	5.	Bucket Cylinder to Bellcrank (1 fitting each side)	LBG
	6.	Bellcrank Pivot (1 fitting each side)	LBG
	7.	Pushrod to Bellcrank (1 fitting each side)	LBG
	10.	Front Steering Cylinder Bushings (1 fitting each side)	LBG
	11.	Steering Drag Link (2 fittings)	LBG
	13.	Lower Pivot Pin (2 fittings)	LBG
	14.	Upper Pivot Pin (1 fitting)	LBG
	18.	L.H. Rear Steering Cylinder Bushing (1 fitting)	LBG
	19.	R.H. Rear Steering Cylinder Bushing (1 fitting)	LBG
	20.	Axle Cradle Bushing (1 fitting)	LBG
	21.	Axle Cradle Bushing (1 fitting)	
100 HOURS ⊟	8.	Pushrod to Bucket (1 fitting each side)	LBG
	9.	Boom to Bucket (1 fitting each side)	LBG
	12.	Propeller shaft (3 fittings)	LBG
	15.	Propeller shaft (3 fittings)	LBG
	16.	Propeller shaft (3 fittings)	LBG
	17.	Propeller shaft (3 fittings)	LBG

KEY
LBG-Lithium base multi-purpose grease
18° (0°F) and above–Grade 2
18° (0°F) and below–Grade 0

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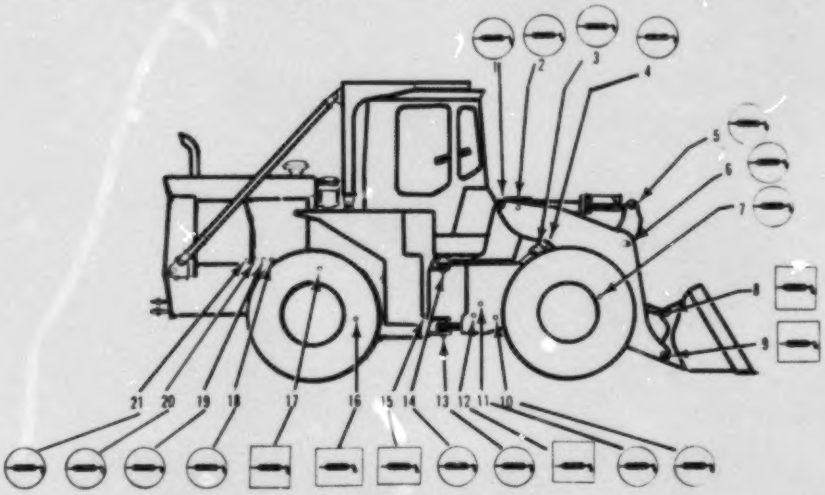


PREVENTIVE MAINTENANCE
UNIT III

JOB SHEET #2--LUBRICATE A HYDRAULIC CRAWLER EXCAVATOR

I. Tools and equipment

- A. Excavator
- B. Grease gun
- C. Container of multi-purpose gear lubricant (MPL) SAE 90 with an extreme pressure (EP) additive
- D. Hydraulic oil (HO)
- E. Container of multi-purpose type grease (MPG) with an extreme pressure (EP) additive

  (NOTE: Grease must have a high resistance to water washout.)
- F. Engine oil SAE 30 (EO 30)
- G. Shop rags
- H. Tool kit
- I. Service manual and lubrication chart

  (NOTE: See next two pages for lubrication charts.)

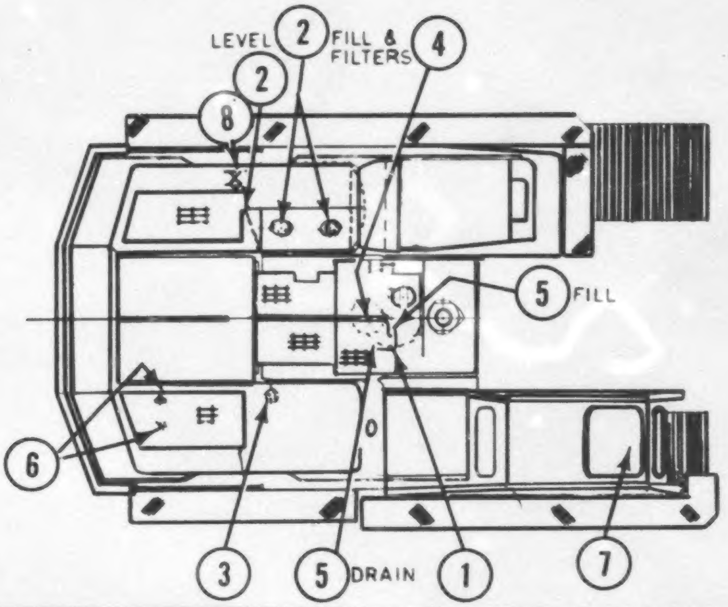
II. Procedure

- A. Clean off grease fittings with rags
- B. Fill grease gun with proper lubricant
- C. Place gun nozzle on grease fitting and apply pressure to release grease

  (NOTE: The manufacturer's maintenance manual for particular piece of equipment will give locations of all grease fittings.)
- D. Proceed with steps A, B, and C, until all fittings have been greased

JOB SHEET #2

Lubrication Chart
325-H Upper Works



Interval Hours	Lube Point	Identification	Total Points	Lube	Quantity Per Point
8	(1)	Swing Gear and Pinion	1	MPG	(A)
10	(2)	Hydraulic Reservoir — Check Level and Add	1 & 2	HO	To Level (D)
(C)	(2)	Hydraulic Reservoir Filters	2	—	2 Elements
(C)	(3)	Swing Filter	1	—	1 Element
50	(4)	Swing Gearcase — Check Level	1	MPL	To Level
(B)	(5)	Swing Gearcase — Drain and Refill	1	MPL	9.3 Quarts (8.8 Litres)
2000	(E)	Hydraulic System — Drain, Flush and Refill	—	HO	150 Gals. (568 Litres)
500	(6)	Swing Servo Control Cylinder Linkage	2	EO 30	Oil Can
500	(7)	Propel Foot Pedal Pins	2	MPG	2 Shots
2000	(8)	High Pressure Filters	2	—	1 Element (F)

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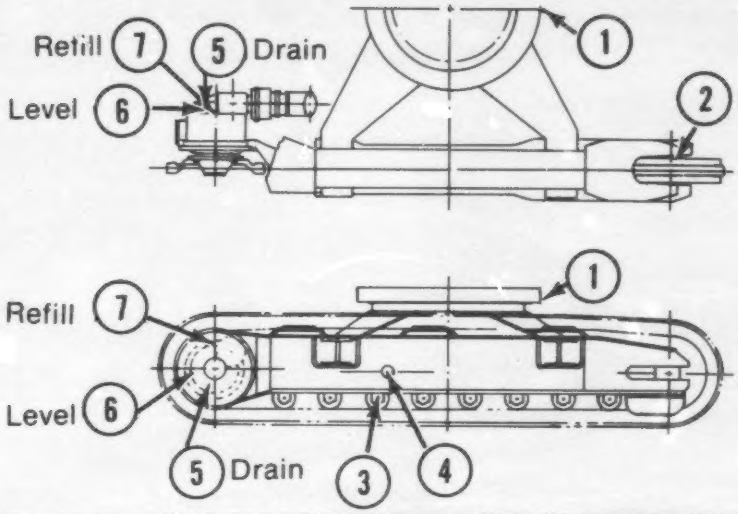
JOB SHEET #2

Lubrication Chart
325-H Lower Works


Refill 7
5 Drain
Level 6
1
2
1
Refill 7
Level 6
5 Drain
3
4

Interval Hours	Lube Point	Identification	Total Points	Lube	Quantity Per Point
50	(1)	Swing Circle	4	MPG	(A)
50	(2)	Front Take-Up Tumbler	2	EO-30	(B)
50	(3)	Lower Rollers	16	EO-30	(B)
As Req'd.	(4)	Track Take-Up and Adjustment	2	MPG	(C)
(D)	(5)	Propel Gear Case — Drain	2	MPL	7 Qts. (6.6 Litres)
50	(6)	Propel Gear Case — Check Level	2	MPL	To Level
(D)	(7)	Propel Gear Case — Refill	2	MPL	7 Qts. (6.6 Litres)

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PREVENTIVE MAINTENANCE
UNIT III

TEST

NAME ______________________________ SCORE __________

1. Match terms associated with preventive maintenance to the correct definitions. Write the correct numbers in the blanks provided.

_____a. Taking care of equipment systematically to reduce repairs

_____b. Substance that reduces friction between surfaces

_____c. Thick lubricant

_____d. Type of grease

_____e. Operating safety feature for gages

_____f. Device containing several oblong abrasive stones arranged in a circular pattern; used to remove small amounts of material from cylindrical surfaces

_____g. A solid material that is not in solution and either is distributed through the liquid or has settled out of the liquid

_____h. Device preventing leakage at a machine joint

_____i. A classification of motor, transmission, and differential lubricants to indicate viscosities standardized by the Society of Automotive Engineers; SAE numbers do not connote quality of lubricant

_____j. Metric unit of pressure similar to psi (pounds per square inch)

_____k. A four-bar linkage in which both cranks traverse full circles; the fixed member must be the shortest link

1. Lubricant
2. Sender unit
3. Grease
4. Preventive maintenance (PM)
5. Alemite
6. Packing gland
7. Kilopascal (kPa)
8. Sediment
9. Drag link
10. Honing stone
11. SAE number

2. Select from the following list factors that should be included in preventive maintenance. Write an "X" in the correct blanks.

_______a. Replacement of all filters

_______b. Capacity of fuel tank

_______c. Scheduled lubrication

_____d. Frequent cleaning of equipment

_____e. Inspections

_____f. Adjustment of all gages

_____g. Daily inspection of lubrication system

_____h. Complete and accurate records

_____i. Prompt correction of defects

_____j. Monthly correction of all defects

3. Select from the following list items to check in a visual inspection. Write an "X" in the correct blanks.

_____a. Lights, for brightness

_____b. Switches and controls

_____c. Thermostat

_____d. Air pressure in tires

_____e. Broken master cylinder

_____f. Leaks, or streaks that may indicate leaks

_____g. Dirt accumulation that could be harmful to machine

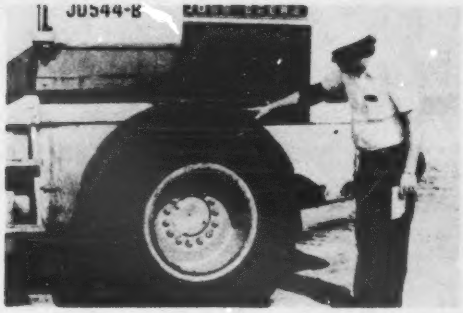
_____h. Condition of windshield

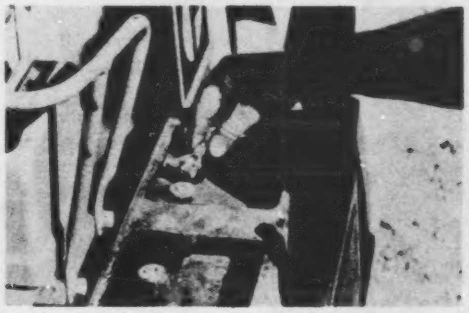
_____i. Damage and condition of tires and/or tracks and under carriage

_____j. Condition of grease fittings

4. Identify items that should be checked on a daily (or shift) checklist. Write the correct names in the blanks under the pictures.

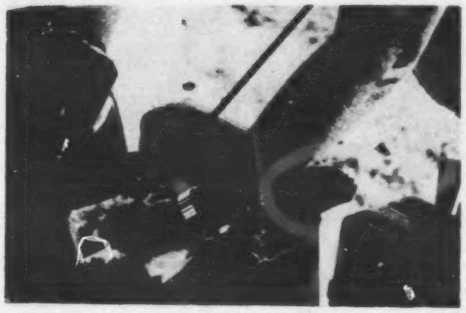
- Tires and tire pressure
- Visual inspection
- Engine oil level
- Transmission fluid level
- Battery electrolyte level; battery connections
- Hydraulic system
- Brakes (testing with foot pedal)
- Air cleaner indicator
- Cooling system level and pressure cap
- Fuel system and supply
- Hydraulic fluid level on sight glass and/or dip stick
- Insulation and connections on wires in electrical system

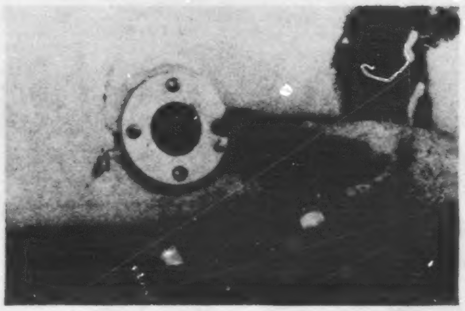




a. ______________________

b. ______________________



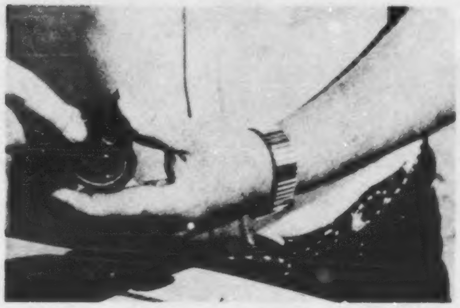


c. ______________________

d. ______________________

e. ______________________

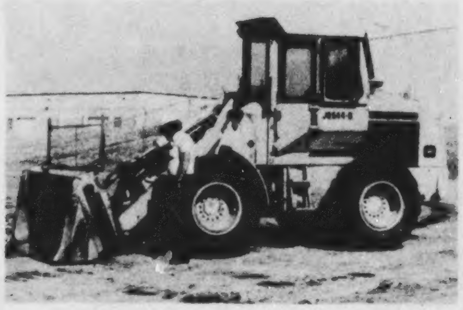
f. ______________________

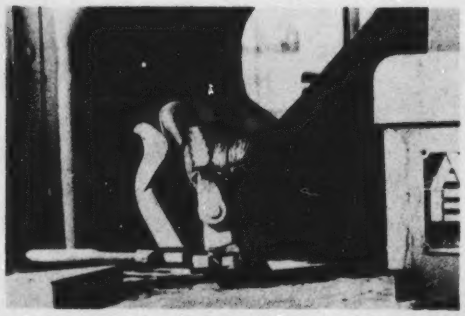


g. ______________________

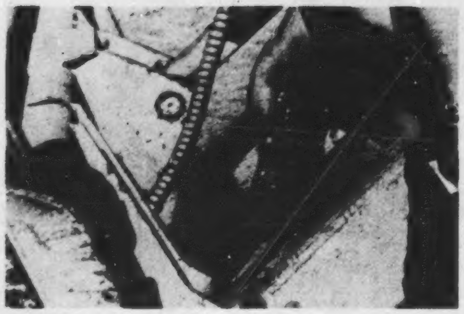
h. ______________________

i. ______________________ ______________________





j. ______________________________ k. ______________________________



l. ______________________________

5. Select from the following list types of preventive maintenance inspections. Write an "X" in the correct blanks.

______a. Daily

______b. Monthly

______c. 150-hour

______d. 1000-hour

______e. 300-hour

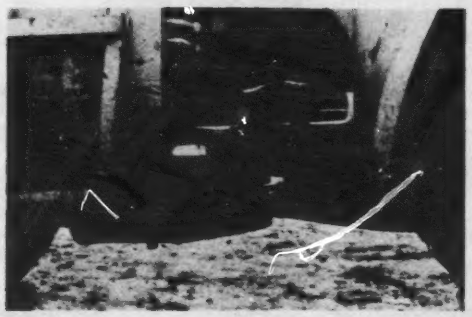
______f. 50-hour

______g. Visual

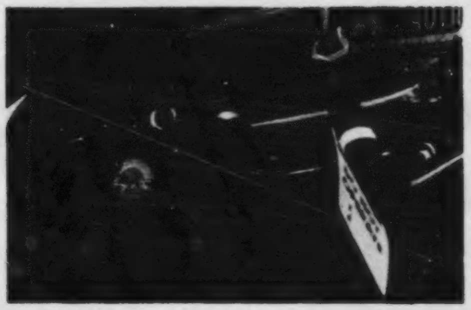
______h. 1200-hour

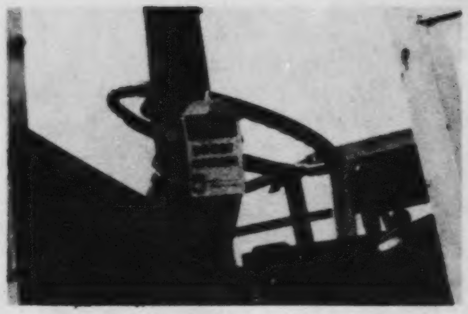
______i. 75-hour

6. Label safe service positions illustrated below. Write the correct names in the blanks under the pictures.

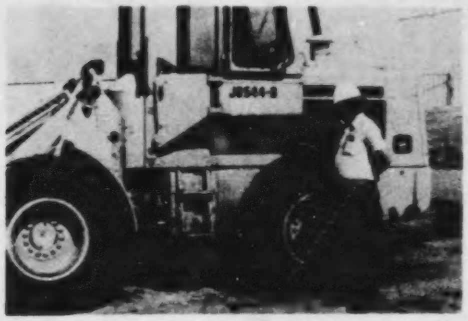


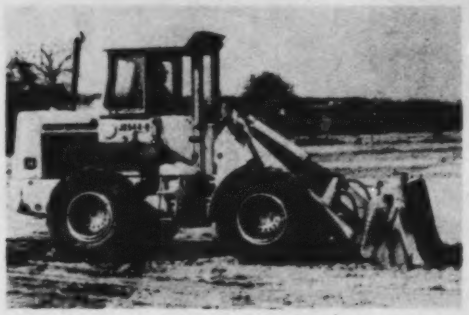
a. ______________________________ b. ______________________________



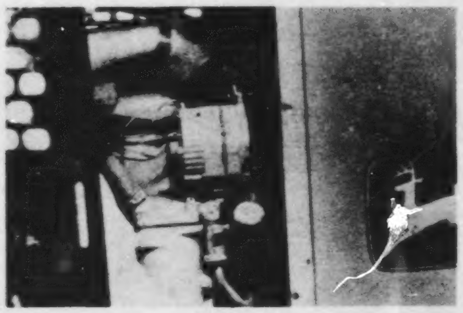


c. ________________________________ d. ________________________________





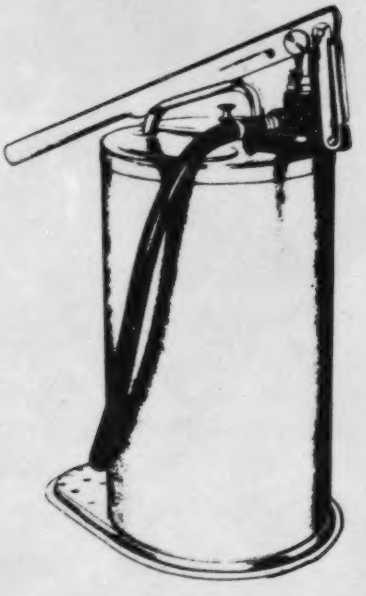
e. ________________________________ f. ________________________________



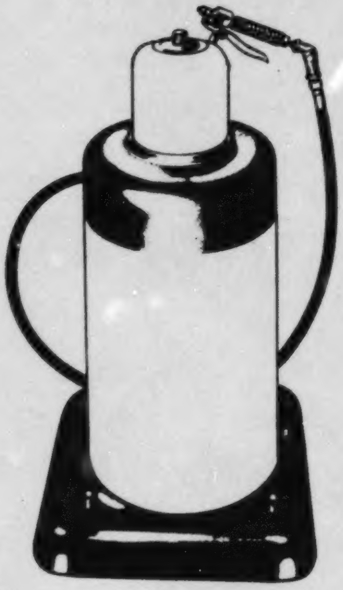
g. ____

7. Identify types of grease guns and grease fittings illustrated below. Write the correct names in the blanks under the pictures.

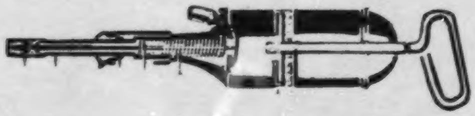
Portable air operated
Lever-type handgun
Foot-lever bucket pump
Grease truck
Alemite® fitting (takes special attachment)
Hydraulic fittings
Handgun loader
Pail cover pump
Volume pressure bucket pump
Flush fitting (takes special attachment)
Push-type handgun
Zerk fitting
Button head fitting (takes special attachment)
Dot fitting (takes special attachment)
Reservoir fitting



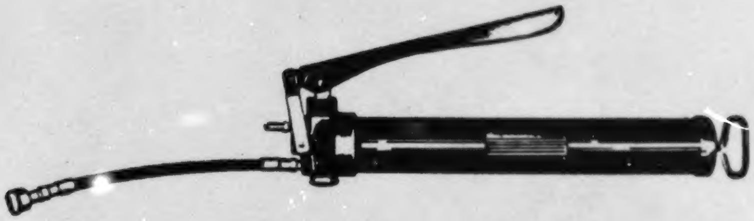
a. ______________________________



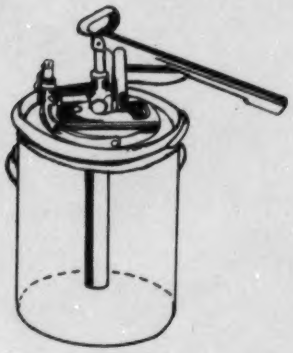
b. ______________________________



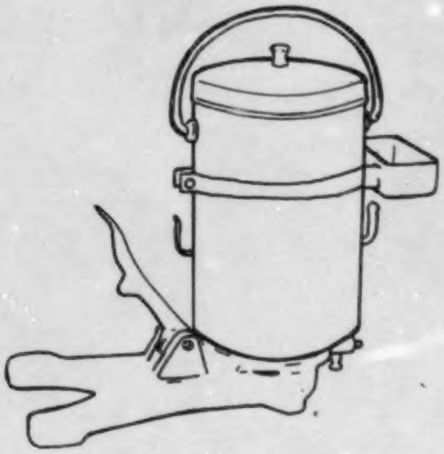
c. ______________________________



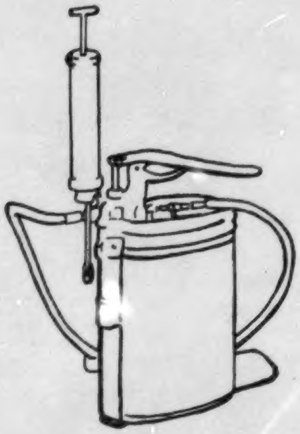
d. ______________________________



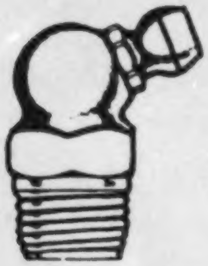
e. ______________________________



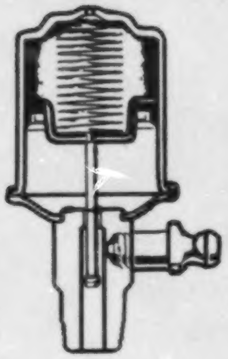
f. ______________________________



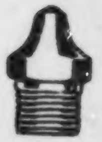
g. ______________________________



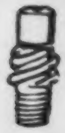
h. ______________________________



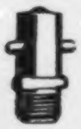
i. ____________________



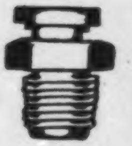
j. ____________________



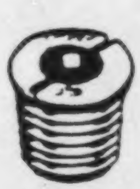
k. ____________________



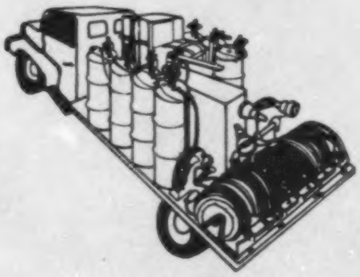
l. ____________________



m. ____________________

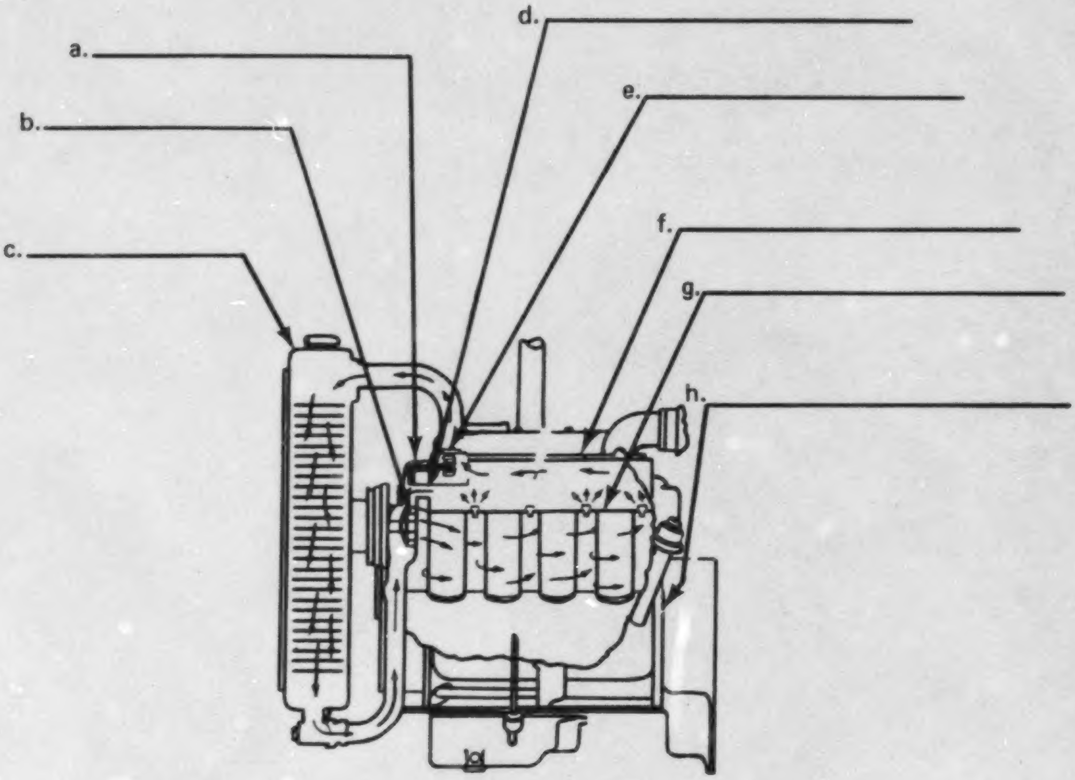


n. ____________________



o. ____________________

8. Label main parts of the cooling system illustrated below. Write the correct names in the blanks provided.



9. State purpose of the cooling system--______________________________

____

____

10. Complete daily (or shift) preventive maintenance inspection.
11. Complete 50-hour preventive maintenance inspection.
12. Complete 250-hour preventive maintenance inspection.
13. Complete 1000-hour preventive maintenance inspection.
14. Demonstrate the ability to:
    - a. Lubricate wheel loader.
    - b. Lubricate a hydraulic crawler excavator.

    (NOTE: If activities 10-14 have not been finished before the test, ask your instructor when they should be completed.)

PREVENTIVE MAINTENANCE
UNIT III

ANSWERS TO TEST

1. a. 4
   b. 1
   c. 3
   d. 5
   e. 2
   f. 10
   g. 8
   h. 6
   i. 11
   j. 7
   k. 9

2. c, d, e, h, i

3. b, d, f, g, i

4. a. Tires and tire pressure
   b. Battery electrolyte level; battery connections
   c. Transmission fluid level
   d. Hydraulic fluid level on sight glass and/or dip stick
   e. Air cleaner indicator
   f. Insulation and connections on wires in electrical system
   g. Fuel system and supply
   h. Cooling system level and pressure cap
   i. Engine oil level
   j. Visual inspection
   k. Brakes (testing with foot pedal)
   l. Hydraulic system

5. a, d, f, g

6. a. Parking brake applied
   b. Safety link connected
   c. Ignition key removed
   d. Steering wheel tagged
   e. Wheels blocked

f. Attachment on ground

g. Engine stopped

7. a. Portable air operated

b. Volume pressure bucket pump

c. Push-type handgun

d. Lever-type handgun

e. Pail cover pump

f. Foot-lever bucket pump

g. Handgun loader

h. Hydraulic fitting

i. Reservoir fitting

j. Zerk fitting

k. Dot fitting (takes special attachment)

l. Alemite® fitting (takes special attachment)

m. Buttonhead fitting (takes special attachment)

n. Flush fitting (takes special attachment)

o. Grease truck

8. a. Water pump air vent line

b. Water pump

c. Radiator

d. Bypass

e. Thermostat (regulator)

f. Cylinder head

g. Cylinder liner

h. Cylinder block

9. Answer should include: To remove heat from the cylinder walls and combustion chambers through the radiator

10. Evaluated to the satisfaction of the instructor

11. Evaluated to the satisfaction of the instructor

12. Evaluated to the satisfaction of the instructor

13. Evaluated to the satisfaction of the instructor

14. Evaluated to the satisfaction of the instructor